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[Telegraphic Journal.]

SECONDARY BATTERIES OF M. PLANTE.

By A. NIAUDET-BREGUET.

SECONDARY currents, or currents of polarization, have formed the subject of numerous researches ever since the period when they were discovered—that is to say, since the commencement of the present century; but it is only within the last few years that it has been ascertained that they are capable of being applied to purposes of practical utility.

During the last fifteen years M. Gaston Planté has been engaged upon the investigation of this subject, and, by continuous efforts and by successive stages of progress, he has arrived at results of the greatest interest—results of the nature of which we shall now endeavor to give an idea.

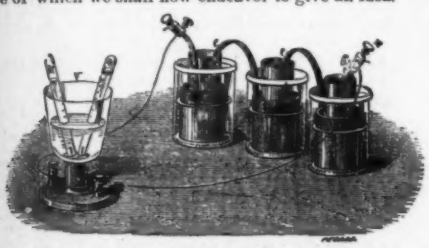


FIG. 1.—VOLTAMETER AND DANIELL BATTERY.

The reader knows that the Voltameter is an instrument in which water is decomposed by the current from an ordinary galvanic battery; in Fig. 1 is represented one of the fundamental experiments in physics. At the exact instant when the Voltameter has been just subjected to the action of the battery, it may be regarded as a secondary couple or element; if the two electrodes are now connected with the wire of a galvanometer the needle of the latter will be deflected during several seconds, and will show the passage of a current which grows gradually weaker and becomes imperceptible after a somewhat short space of time. This current is what is called a secondary current; it has been supplied by the battery to the Voltameter, and it is given back again by the latter.

M. Planté showed, as early as 1859, that lead is the most suitable metal for employment in secondary batteries, and he has, since that time, still further confirmed the superiority of this metal. Fig. 2 shows a secondary element as now constructed. In a tall vessel of glass, gutta-percha, or ebonite, are placed two sheets of lead, rolled spirally, and parallel one to the other, and kept from touching by two cords of india-rubber rolled up with them; these two sheets of lead are immersed in a solution of one part of sulphuric acid to nine parts of water. The vessel is closed by a sealed cover pierced

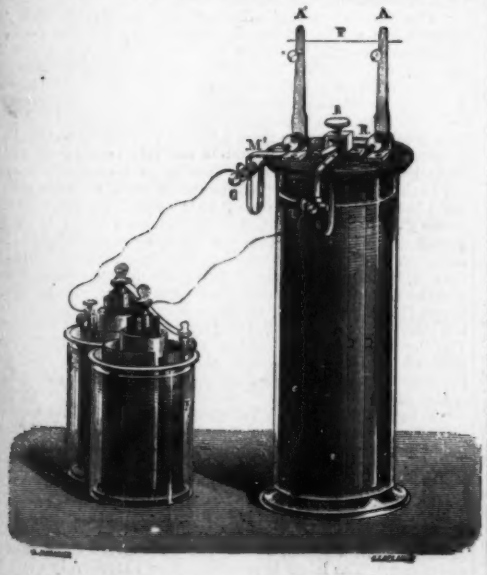


FIG. 2.—TWO BUNSEN ELEMENTS CHARGING A SECONDARY ELEMENT.

with a small hole, through which the liquid can be poured in or extracted, and which also allows the escape of any gas which may be generated during the charging of the battery. The apparatus is surmounted by a disc of ebonite, upon which are fixed two contact pieces in connection with the two electrodes; two clips are also provided for the purpose of holding metallic wires to be made red hot or melted by the secondary current.

Two Bunsen cells, or, in their stead, three Daniell cells, are required to charge this secondary element. During the operation of charging one of the electrodes oxidizes, a brown coating of peroxide of lead soon shows itself, and the metallic appearance disappears entirely; the other electrode also changes in appearance, its surface becomes covered with a powdery gray coating.

When the charge has attained its maximum—that is to say, when oxygen commences to be given off by the brown electrode, it is well to disconnect the secondary element from the charging battery, for any further expenditure of the polarizing current is entirely wasted.

The secondary element once charged in this manner and left to itself will retain a portion of its charge for several days; and even at the end of a week it is still far from being exhausted.

The secondary element, when fully charged, has an electromotive force equal to one and a half times that of a Bunsen; it will redden a platinum wire of a greater or lesser diameter according to its size, or rather according to the size of the electrodes; for it is of course understood that the quantity of

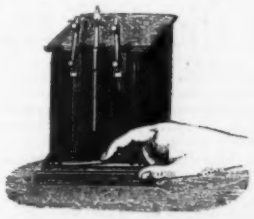


FIG. 3.—SATURN'S TINDER-BOX.

electricity which the apparatus can furnish is in proportion to the extent of the surface subjected to the action of the polarizing current and covered with an active electro-chemical deposit.

It should be remarked that the particular (spiral) form of the electrodes gives an element having a large surface and a small resistance within a small space, so that one of Planté's secondary elements is equal to an active or ordinary element of a very unusual size; the small pattern has an active surface of 8 square decimetres (124 square inches), the large pattern a surface of 40 square decimetres (620 square inches).

The current furnished by the secondary element will effect chemical decomposition, act upon an electro-magnet, etc.; but if its intensity is measured by any of the ordinary methods, as, for example, by means of a galvanometer, it will be found to decrease gradually from the maximum spoken of above. This diminution is rather slow if the circuit has a large resistance, and if, in consequence, the electricity passes in small quantity; but it is, on the contrary, very rapid if the circuit is one of but small resistance, because the electricity then flows in large quantity.

The period of discharge gives rise to an interesting observation. The battery is to all appearance completely discharged, but if it is allowed to rest for a few minutes with the circuit disconnected, it is found to have reacquired a certain amount of force, and is able again to give forth a certain quantity of electricity. The battery being then discharged of the first *residuum* and again left to itself for a short time, will give a second *residuum* smaller, indeed, than the first. The latter will not be the last; several other charges can still be obtained.

M. Planté has very clearly explained this peculiarity. The secondary element when it comes into action is discharged, and is at the same time polarized, as in the case of batteries with a single fluid. This polarization acquires after a certain time a power almost equal to that of the weakened secondary element, and the action then ceases or becomes very slight. If the battery is now allowed to rest it depolarizes itself, as happens in the case of all single fluid batteries polarized by their own action; the battery, once depolarized, is then again ready to give forth a current, but in the next discharge it becomes polarized afresh and so on.

Let us now suppose that the secondary element has been entirely discharged or nearly so, it can be recharged by means of the two Bunsen elements as at first; but it is worthy of note that a fresh charge is communicated all the more quickly as the operation is performed more promptly after the discharge.

Moreover, a secondary element is all the better for having been charged and discharged a greater number of times; at first, when it is almost new, there is an advantage in polarizing the electrodes, sometimes in one direction and sometimes in the other, reversing several times the direction of the charge; but when the element is formed the greatest care must, on the contrary, be taken to charge it always in the same direction. If this precaution is neglected the time required for charging will be much increased, for the oxide of lead which may happen to remain upon one of the electrodes must be reduced, and the plate, previously negative, must be oxidized. But after this operation the secondary element regains all its power, and may even be said to be all the better for it.

Fig. 3 shows a peculiar form in which M. Planté has arranged the secondary element, and to which he has given the name of *Briquet de Saturne* (Saturn's tinder-box). On the upper part of the box may be seen two small clips, between which is stretched a platinum wire; every time that, by pressing with the finger, the two springs at the bottom of the box are brought in contact, the battery sends a current through the platinum, and heating it to redness, the taper is then lighted almost instantaneously. With an apparatus of this kind well charged, the taper may be lighted one hundred times, and it is only after being used this large number of times that it is necessary to recharge with three Daniell elements. Thus we have a new means of obtaining fire, and a very economical one, for the secondary element itself consumes nothing and the charging battery merely a few grammes of sulphate of copper for supplying the apparatus during a very long period.

The same apparatus might be employed either in civil or military engineering for exploding mines; it has been shown by experiment that with fuses of rather fine platinum wire (one twentieth of a millimetre in diameter), an explosion can be obtained through a copper wire 900 metres long and three millimetres in diameter.

With an apparatus of a similar kind, surgeons are enabled to cauterize a wound, and this application has already been often brought into practical use; a secondary element is much more easily carried into an hospital, and especially into the house of a patient, than the active elements which it is capable of replacing.

These secondary elements can be joined together, either for intensity or for quantity, and they form batteries capable of producing all the effects of batteries of the ordinary form, and of the most powerful kind. Fig. 4 represents a secondary battery as arranged by M. Planté, and such as would render the most valuable service in a variety of applications.

The number and size of the couples require to be varied, in order to obtain given effects of tension and quantity. Here, we have twenty elements arranged in two rows; at the upper part is an ingeniously contrived commutator, so arranged that in one position it joins all the elements together for quantity, and in another, at right angles with the first, it groups them for intensity. In the first position all the outer electrodes are joined to one metallic bar, and all the inner electrodes to another similar bar, so that the whole apparatus is equivalent to a single element of very large surface; it is whilst in this position that the secondary battery is charged; two Bunsen elements are sufficient to effect a complete charge, the time occupied being longer or shorter according to the size of the charging cells and the extent of the leaden surface to be polarized. In the second position of the commutator, the exterior electrode of each element is connected to the interior electrode of the next element, and the apparatus becomes a real battery of twenty cells; it is whilst connected in this manner that the battery is discharged; the power at

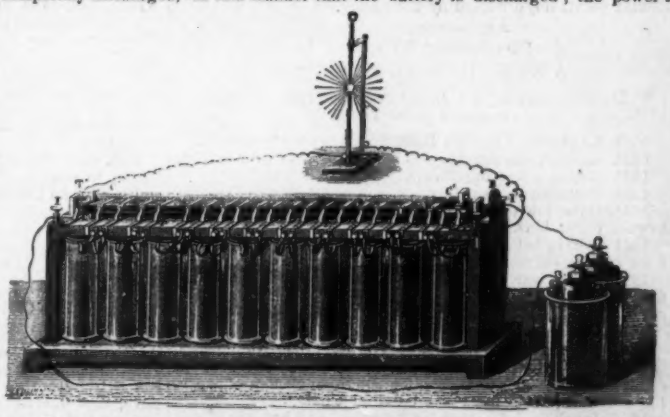


FIG. 4.—SECONDARY BATTERY OF TWENTY ELEMENTS, CAPABLE OF BEING CHARGED WITH TWO BUNSEN ELEMENTS WHEN ARRANGED FOR QUANTITY, AND PRODUCING LIGHT UPON BEING DISCHARGED WITH INTENSITY CONNECTIONS.

the beginning of the discharge is equal to thirty Bunsen elements of very large surface.

As the discharge proceeds, the tension falls, as we have explained when speaking of the single secondary element. If one minute has been the time occupied in charging the secondary battery, in quantity, from the two Bunsen elements, it can not be expected that the discharge, in intensity, will produce the effect of thirty Bunsen elements of the same size during more than four seconds, for the apparatus does not produce electricity, and can only transform that which is imparted to it. M. Planté has made exact experiments upon this point, and has found that in the transformation about one tenth part is lost, or, in other terms, that the apparatus gives back nine tenths of what has been expended.

It is easily perceived that the secondary battery can only produce effects of short duration, but in a very great number of cases such effects are all that is required.

If, for example, it is desired to explode simultaneously a large number of mines by means of fuses of fine wire, the object can be attained by joining all the fuses as branches out of a single wire, and discharging a secondary battery into all of them simultaneously. This plan is a very economical one; there is no doubt that it involves much less labor and

cost to set up two Bunsen elements and charge the secondary battery than to charge the twenty or thirty Bunsen elements whose place is supplied; it being of course understood that the work is required from the battery during but a few seconds, and that the operation is repeated but four or five times in the course of the day. Moreover, the secondary battery can be easily carried about to the different workshops where the works extend over a considerable area, as during the construction of a long tunnel or the sinking of shafts for mines.

In small laboratories the expense of setting up a large Bunsen battery is an obstacle to the carrying out of certain experiments, either for demonstration to pupils or for the investigations and researches of the teacher. The greater number of these experiments become possible by the use of the Planté battery. If, finally, this apparatus is used in combination with a Gramme machine instead of an ordinary battery, all handling of acids is got rid of, as well as all other expense except the purchase of the apparatus, which will last an indefinite time.

We have the greatest confidence in the future of this combined employment of the secondary battery and the Gramme machine, and we shall show in conclusion how it furnishes a solution to the important problem of lighting ships with a view to the avoidance of collisions at sea.

It is not by any means necessary to exhibit at the top of the mainmast a permanent electric light; it will be enough to secure a vessel from collision if it gives warning of its presence around the horizon by a signal of two seconds' duration shown once a minute. Now an intermittent light of this kind can be produced by a secondary battery alternately charged and discharged; charged from a Gramme machine during fifty-eight seconds and discharged during the remaining two seconds. Upon steamers, which it is specially necessary should be well lighted, the engines will work the Gramme machine and the electric light will, as a fact, have its origin in the fuel which heats the boilers. Upon large sailing vessels an electric light would also be found useful, at least on foggy nights. In order to produce it, all that is necessary is to add to the arrangement of which we have spoken an apparatus, by means of which a sailor working alternately two pedals would turn a Gramme machine, and thus produce the exciting current for the secondary battery.

In both cases the movement of the commutator of the battery could be effected automatically after the completion of the number of revolutions of the Gramme machine required to charge the battery, and a second time after the number of revolutions corresponding to the duration of the effective discharge. In this way the flashes and intervals of darkness would be self-produced without any personal intervention or supervision.

It will be observed that this system of intermittent lighting would permit the arrangement of certain useful combinations; for example, the Transatlantic Company might adopt a flash of two seconds every minute, the Cunard Company another variation, such as a flash of one second every quarter minute, the Peninsular and Oriental Company, a different combination, etc., etc. The result would be that any one coming within the horizon of these vessels would know to which company they belonged, and would be able, in case of necessity, to furnish useful information. With a system of this kind it would be easier to know the character of a ship by night than by day. A ship in distress should signal by a peculiar arrangement of flashes, to be adopted by vessels of all nations, and to be understood by all; such a signal would be more distinct than the firing of guns or blowing of whistles, which are often rendered inaudible by the noise of the storm. Lastly, in the case of a squadron sailing in company, the flashes could be used to transmit the orders of the chief commander to the commanders of the other vessels; the alphabets at present in use could be easily transformed and adapted to this new means of communication.

We may add that the proposed combination is applicable to the transmission of signals between different points in a besieged place, or of large entrenched camps such as it is proposed to establish for the defence of the French territory; it would also enable those besieged to communicate with very distant points not occupied by the enemy.

[Manufacturers' Trade Journal.]

A NEW PILGRIM'S PROGRESS.

MILE-STONES IN HIS JOURNEY FROM 1620 TO THE PRESENT NEW YEAR.

1620. Lands on Plymouth Rock, and sets up for himself.
1621. Keeps Thanksgiving—is in no danger of over-eating.
1632. Builds a Meeting-House.
1633. Proclaims a Fast-Day.
1638. Cuts down a May-Pole at Merry Mount as a rebuke to vain recreations.
1635. Is crowded for accommodations, and stakes out a new farm at Connecticut.
1637. Makes war on the Antinomians and the Pequod Indians, and whips both.
1638. Starts a College.
1640. Sets up a Printing-Press.
1643. Goes into a Confederacy—The first Colonial Congress.
1648. Lays down the Cambridge Platform. Hangs a Witch.
1649. Sets his face against the unchristian custom of wearing long hair, "a thing uncivil and uncomely."
1651. Is rebuked for "intolerate excess and bravery of apparel," and is forbidden to wear gold and silver lace, or other such gewgaws.
1652. Coins Pine-Tree Shillings—and makes the business profitable.
1663. Prints a Bible for the Indians.
1680. Buys a "hang-up" Clock, and occasionally carries a silver watch, that helps him guess the time of day. About this period learns to use Forks at table; a new fashion.
1692. Is scared by *Witches* again at Salem, but gets the better of them.
1702. Founds *another College*, which at last settles down at New-Haven.
1704. Prints his first *Newspaper*, in Boston.
1705. Tastes *Coffee* as a luxury, and at his own table.
1708. Constructs another *Platform*—this time at Saybrook.
1710. Begins to sip *Tea*—very sparingly.
1711. Puts a letter in his first *Post-Office*.
1720. Eats a *Potato*, and takes one home to plant in his garden as a curiosity.
1721. *Inoculated* for the small-pox—not without grave remonstrance from his conservative neighbors. Begins to *Sing by nots* on Sundays, thereby encountering much opposition and opening a ten years' quarrel.
1740. Manufactures tinware, and starts the first *Tin Pedlar* on his travels.
1742. Sees Faneuil Hall built. The Cradle of Liberty is ready to be rocked.
1745. Builds an organ; but does not permit it to be played in the Meeting-House.
1750. Buys a bushel of potatoes for winter's use—all his friends wondering what he will do with so many.
1755. Puts up a *Franklin Stove* in the best room, and tries one of the newly-invented *Lightning-Rods*.
1760. About this time begins to wear a collar to his shirt. When he can afford it, takes his wife to church in a *Chaise* instead of on a pillion, as heretofore.
1765. Shows his dislike for stamped Paper, and joins the "Sons of Liberty."
1768. Tries his hand at *Type-Founding*—not yet successfully—in Connecticut.
1770. Buys a home-made *Wooden Clock*.
1773. Waters his *Tea*, in Boston harbor. Plants *Liberty Trees* wherever he finds good soil.
1774. Lights Boston streets with oil *Lamps*, a novelty (though "New Lights" have been plenty for some years).
1776. *Brother Jonathan*—as he begins to be called in the family—declares himself free and independent.
1780. Buys an "Umbrillo" for Sundays, and whenever he shows it is laughed at for his effiminacy.
1791. Starts a *Cotton-Spinning* factory.
1792. Has been raising Silk-Worms in Connecticut, and now gives his minister (not his wife) a home-made silk gown. Buys a *Carpet* for the middle of the parlor floor.
1793. Invents the *Cotton-Gin*, and thereby trebles the value of Southern plantations.
1795–1800. Wears *Pantaloons* occasionally, but not when in full dress. Begins to use *Plates* on the breakfast and tea table.
1802. Has the boys and girls *vaccinated*.
1806. Tries to burn a piece of *Hard Coal* from Philadelphia. A failure.
1807. Sees a boat go by *Steam*, on the Hudson.
1815. Holds a little *Convention* at Hartford, but doesn't propose to dissolve the Union. Buys one of Terry's patent "Shelf-Clocks" for $36, and regulates his watch by it.
1817. Sets up a stove in the Meeting-House, and builds a fire in it for Sunday; an innovation which is stoutly resisted by many.
1818. Begins to run a Steamboat on Long Island Sound, and—after making his will—takes passage on it to New-York.
1819. Grown bolder, he crosses the Atlantic in a Steamship.
1822. Lights *Gas* in Boston. At last learns how to make hard coal burn, and sets a grate in his parlor. Buys a *Steel Pen* (one of Gillott's, sold at $33 per gross). Has his every day shirts made without *Ruffles*.
1825. About this time puts a *Percussion Lock* on his old musket.
1826. Buys his wife a pair of queer-shaped *India-Rubber* overshoes. Puts on his first *false* collar.
1828. Tastes his first *Tomato*—doubtingly. Is told that it is unfashionable to feed himself with his knife, and buys silver forks for great occasions.
1832. Builds a *Railroad*, and rides on it.
1833. Rubs the first *Friction-Match*—then called "Lucifer," and afterwards "Loco-foco." Throws away the old Tinder-Box, with its flint and steel.
1835. Invents the *Revolver*, and sets about supplying the world with it as a peacemaker. Tries a *Gold Pen*, but can not find a good one yet, not till 1844.
1837. Gets in a Panic—and out again, after free use of "shinplasters."
1838. Adopts the new fashion of putting his letters in *Envelopes* (a fashion which does not fairly prevail till several years later).
1840. Sits for his *Daguerreotype*, and gets a tearfully and wonderfully-made picture. Begins to blow himself up with "Camphene" and "Burning Fluid," and continues the process for years, with change of names of the active agents, down to and including "Non-Explosive Kerosene."
1844. Sends his first message by the *Electric Telegraph*.
1847. Buys his wife a *Sewing Machine*, in the vain hope that somehow it will keep the buttons on his shirts. Begins to receive advices from the "Spirit World."
1855. Begins to bore and be bored by the Hoosac Tunnel.
1858. Celebrates the laying of the *Ocean Cable*, and sends a friendly message to John Bull. Next week begins to doubt whether the cable has been laid at all.
1861. Goes South, to help compose a family quarrel. Takes to using Paper Money.
1861–1865. Climbs the Hill difficulty—relieved of his Pack, after January 1st, 1864, and loses Great-Heart at last, April 14th, 1865.
1865. Gets the Atlantic Cable in working order at last, in season to send word to his British cousins, who have been waiting for an invitation to his funeral, that he "lives yet."
1864–1875. Is Reconstructing and *talking about* Resumption. Sends his boys to the Museum to see an old-fashioned Silver Dollar.

[Nature.]

THE ORIGIN OF OUR NUMERALS.

MR. DONISTHORPE'S ingenious construction of our numerals by corresponding numbers of lines (*Nature*, vol. xii. p. 476) induces me to offer a few remarks on this subject, which has a literature of its own. There can be no doubt, I believe, that our forms were derived directly from the Arab series called Gobar; that the Arabs had them from the Indians, and the Indians from the Chinese. My esteemed friend Dr. Wilson, of Bombay, published a "Note on the Origin of the Units of the Indian and European Numerals," in 1858,* in which he showed the derivation of some of our numerals from ancient Indian forms found on cave inscriptions of Western India, on the Bhilsa Topes, and on coins. My remarks are founded wholly on the forms given in this note, which is little known, I believe, in England.

Dr. Wilson obtains our first four numeral forms from the Chinese, traced through different Indian script characters nearly as supposed by Mr. Donisthorpe. One, two, three horizontal bars and a square for 4. He also finds the eight in the forms of , , and on the cave inscriptions.

Before proceeding to the other numerals I wish to notice a rule which may be deduced from the consideration of the changes in the forms of numerals in passing from one people to another, that the same form may be turned through angles of 90° or 180°, and may be inverted or reversed without altering its value. Even the same people have used a form turned in different ways for the same numeral. The Arabs used their 2, 3, and 4 in two ways, making angles of 90° with each other; the 2, 4, and 5 of Sacro Bosco and Roger Bacon were the Indian script Modi (and ours) turned through 180°, or upside down; other examples will be noticed.

The most important derivations by Dr. Wilson is that from the Chinese ten; this is found on the Bhilsa Topes with a circle round it (Dr. Wilson thinks to distinguish it from the oldest form of K found on the cave inscriptions). The nine is found on the Bhilsa Topes as , or one under ten, and on old coins thus: . The Indian caves give half of ten , , for five (as V is the half of the Roman ten, X). It is from this form that Dr. Wilson derives the Indian Modi and Nagari fives, . It is here that I venture to differ slightly from Dr. Wilson. One of the cave forms of four is , which Dr. Wilson interprets (as in the case of nine) one under five, or five less one; now this form without the under bar, as well as the other forms of five, are, it seems to me, the halves not of the cross (+) merely, but of the cross and circle thus: , which are as nearly as possible two half diameters and half circumference. The form is, I believe, the origin of our four and not the Chinese or Indian square, as supposed. This I think will be evident when we compare the Arab four ( ) with the Indian four above. The Arab four is also employed thus: which inverted gives , a sufficiently near approximation to our four.

Dr. Wilson has not been able to find the origin of our seven, but this is obtained from his Arab seven , by turning it round (>) and making one leg shorter than the other, nearly resembling the Gobar seven . We may also find an earlier source in the Chinese seven turned round 180°, , which is almost exactly the German written seven. Neither six nor seven is to be found on the cave inscriptions. In Dr. Wilson's Arab series the Indian five is used for six, and the Gobar six, as well as ours, may be taken from the Nagari seven . We may also find an origin in the Chinese six , by omitting the horizontal bar, as in the case of the seven. That such liberties were taken is evident on a consideration of the five of Sacro Bosco and Roger Bacon ( ), the Indian five *without the bar*, and turned round 180°.

If there is any merit in these suggestions it belongs to Dr. Wilson.

JOHN ALLAN BROUN.

* See "India Three Thousand Years Ago." By John Wilson, D.D., F.R.S. (Bombay: Smith, Elder & Co., 1858.)

THE SOCIETY OF TELEGRAPH ENGINEERS.

THE annual soirée this year was held at the well-known rooms of Messrs. Willis, at St. James's.

Among the exhibits was an extraordinary amount of apparatus brought forward to demonstrate the life and works of the late Sir Charles Wheatstone; it was, without exception, the most complete record of his "life" ever produced. Starting from an admirable picture of the deceased, instrument after instrument showed the work of forty years. Amongst them the very one which first made his name—the actual apparatus by means of which he performed his great experiment of measuring the velocity of light.

"The Needle System."—The exhibit commences with the original five-needle telegraph, patented by Messrs. Cooke & Wheatstone in 1837, and first tried experimentally, and with success, on the 25th July, 1836, between the Euston and Camden stations on the London and Birmingham Railway. A specimen of the conducting wire used on that occasion forms an exhibit in connection with this instrument. A five-needle telegraph is also shown which was used on the Paddington and Drayton line, and is the very instrument which signalled the fact of a murder having been committed, leading to the immediate apprehension of Tawell. This instrument became celebrated owing to the murderer being dressed in the garb of a Quaker, and there being no letter Q in the alphabet, the clerk had extreme difficulty in spelling the letter Q. This instrument was followed by the four-needle telegraph, and almost immediately by the double-needle, which was the instrument practically adopted by the Electric Telegraph Company in 1846, when it became incorporated after the purchase of the patents of Messrs. Cooke & Wheatstone. The double-needle, under the various dates of 1840, 1851, 1863, and of the latest date, is shown. The single-needle of the ancient type, and that form now used by the Post-office, is also exhibited.

"Wheatstone's A. B. C. Telegraph."—These exhibits exemplify the gradual development and improvement of the first alphabetical telegraph patented by Wheatstone in 1840, and known as the "revolving disc telegraph," to the most modern form of the A. B. C., which is capable of being used as an ordinary indicating telegraph, and also as a type-printing instrument, both actuated by the same means of transmission. This group of instruments exhibits various forms of the same kind of instrument, actuated by voltaic as well as by magnetic electricity. The latest type is that now extensively used by the Post-office.

"The Wheatstone Automatic Telegraph."—This collection of instruments represents the gradual development of the automatic system of telegraphy introduced by the late Sir Charles Wheatstone. It shows the various early types with their gradual improvements, until the completeness is arrived at in the set of apparatus now used by the postal telegraph system, over a mileage of 20,000 miles of wire. The exhibits of these three systems is the most unique and complete ever before brought together, and is obtained from the collection of the late Sir Charles Wheatstone, and from many specimens the property of the Post-office.

"Wheatstone's Bridge or Parallelogram, and Resistance Coils."—The small board represents the original bridge constructed by Sir Charles Wheatstone, and which is now so widely known. Its description is contained in the Bakerian

lecture delivered by him before the Royal Society in 1840. The circular set of resistance coils is of the same period.

One of the most interesting things of the evening was the "Foucault experiment," illustrating what may be termed "magnetic friction." We again appeal to the excellent catalogue. "Gramme magneto-electric machine with Jamin magnet." The Gramme machine is a successful attempt to obtain a uniform and continuous flow of electricity by means of the rotation of a peculiar armature between the poles of a magnet. This armature consists of a broad ring of iron around which insulated copper wire in separate coils is wound. The ends of these coils are connected to small insulated contact pieces fixed around the axle of the armature. Two springs press against these contact pieces, to which the conducting wires are fixed. A magnet provided with soft iron armatures encircles closely the ring and coils. When the ring with its coils rotates, the position of the several coils is changing with respect to the magnet poles, and currents are induced in them; the currents induced in the coils approaching a line drawn between the contact springs being of a reverse kind to the currents in those coils which are receding from it. There is consequently a stream of electricity flowing to the two springs The direction of the stream depends upon the direction of the rotation of the armature and upon the way in which the coils are wound.

"Foucault's experiment."—In this experiment a disc of copper is made to rotate rapidly between the poles of a powerful electro-magnet. When the magnet is excited, the disc, which formerly turned freely, meets with considerable opposition, and if the rotation be persisted in the disc becomes heated. The rise in the temperature, according to Foucault, varies directly as the square of the velocity of rotation.

Mr. Alfred Apps, as usual, exhibited a valuable collection of scientific apparatus, consisting of induction coils and vacuum tubes, whilst Mr. Browning showed a grand display of microscopes and spectroscopes. Amongst the items were some specimens of the "limnoria terebrans," a small marine insect of especial boring capabilities, and highly damaging to submarine cables. The effects of its ravages and those of the ordinary "teredo" were exemplified by a large series of specimens exhibited by the secretary of the society.

Mr. Latimer Clark, the President, showed his new hydraulic dock and boat-lowering apparatus, and also a valuable collection of old books. As president of the society, he exhibited the bust of the late Sir Francis Ronald, with the first deed of the gift of the Ronald Library. This was accompanied by the catalogue of the library, written by the late Sir Francis Ronald, consisting of over 13,000 entries, and numerous old works belonging to the library.

Amongst the other exhibits may be mentioned Mr. C. E. Spagnoletti's apparatus for block signalling; making signals by electricity; the new thermo-electric pile of M. Clamond; various electrical apparatus by Elliott, Warden, and Spiller. Submarine telegraphy was well represented by many interesting specimens, amongst which was an exhibit by Mr. Willoughby Smith of a piece of the original gutta-percha cable laid between Dover and Calais in 1850, recovered lately, having been submerged for twenty-five years, and now electrically in perfect condition.

[National Car-Builder.]

NEW-YORK, NEW-HAVEN AND HARTFORD RAILROAD SHOPS, AT NEW-HAVEN.

THESE shops are very favorably located near the new passenger depot. The space occupied is flanked upon one side by the road-track, and on the other by the water of the bay, with plenty of room for a proper disposition of the various buildings, and with the necessary facilities of easy and convenient access. The new depot is a large and spacious brick structure fronting directly upon the water, with well-arranged interior accommodations and an abundance of platform room outside. In these and other respects it is a marked improvement upon the old one, and can not fail of being duly appreciated by the travelling public. The car and locomotive shops and contiguous buildings are substantial brick structures well adapted to their respective uses. The general repairing is done here for the consolidated line, and also for the leased Shore Line from New-Haven to New-London. A considerable amount of new work is also turned out from time to time.

The car department for several years past has been under the supervision of Mr. James Denver, whose experience and capacity as a master car-builder eminently qualify him for the position he occupies. There are at present about 100 men employed in this department, who are engaged in current repairing. In addition to current repairs, there have been built during the year, 13 new passenger-cars, 1 mail-car and 2 baggage-cars, and it is contemplated to begin the construction of several more passenger-cars at an early day. The freight traffic of the road is comparatively light, the earnings from this source being less than half of the passenger earnings. The present equipment comprises about 200 passenger-train cars, including mail, baggage and express, and 1400 freight-cars of all kinds. There are now running over the line 12 passenger day-cars that were built at these shops last winter, and which will compare most favorably, as respects workmanship, design and finish, with any others of their class that we have seen. We had an opportunity of inspecting one of them in the shop yard, and also of riding upon another on our return to New-York. They are 55 feet in length, and will seat 72 passengers. What first attracts attention is the style of inside finish, which has a certain pleasing effect not traceable to any one or more conspicuous features, but is the result of a general harmony and subordination of every part to every other part. The cabinet work consists of the usual fine fancy woods, mouldings and panelling, but with no apparent straining for effect. The seat cushions and both sides of the seat backs are upholstered with a superior quality of scarlet plush, which gives to the lower part of the car a decidedly rich and warm color-tone. This is very judiciously as well as artistically supplemented by the prevailing red tints of the head-lining, and a succession of narrow gilt mouldings in the upper portions of the car. The ornamental cabinet work of rosewood and mahogany is rich, but comparatively plain, and the combined effect is an agreeable harmony resulting from fitness and adaptation both of color and material. This style of finish would not of course be suggestive of coolness on a sultry July day, but it pleases because there is nothing discordant about it. Nobody feels an impulse to quarrel with it, or is dissatisfied without being able to define the cause, as is always the case when incongruous things are placed in juxtaposition. Another feature of this inside work which the casual observer would hardly notice, but which contributes not a little to the general effect, is the skillful way in which the upper end-corners are rounded, instead of being left square. Nor has this principle been overlooked in many of the minor details; and we think if car-builders generally would organize a more active crusade against sharp edges, abrupt corners and rigid lines, the effect as a whole would be as pleasing as that produced by the almost imperceptible curves in the architectural lines of the Parthenon, to say nothing of the physical comfort to arms, backs and elbows. We noticed also that the slat-blinds of the windows could be shoved to the top of the glass so as to make the entire window available for light or a better prospect. The cars have Baker heaters, and 4-wheeled trucks, with four check-chains to each truck. Instead of elliptics, the swinging-bolster rests upon two enormous rubber springs—we should say about 12 x 14 inches in size—with rubber springs of the ordinary size on the equalizers. This arrangement certainly secures easy riding, but the economy of these large springs can be better determined after a few years' more service. All the passenger-cars of the road have Miller platforms and couplers, and Westinghouse brakes.

In passing through the various departments, especially the paint-shop and locomotive round-house, we noticed that great cleanliness and tidiness everywhere prevailed, indicating that order and system were the rule and not the exception.

The locomotive department is in charge of Mr. H. Kittendorf, the superintendent of motive power and machinery, who has been connected with the road for some 25 years. This department includes a machine and erecting shop, boiler shop, blacksmith shop with 20 forges and 2 steam hammers, and a round-house containing 40 stalls. A few new locomotives are built here, but the work done is principally repairing. The road has 93 engines of all kinds. The grade and traffic require none but the 8-wheeled passenger type for train work. Some of these have 5 ft. and 5 ft. 9 in. drivers, with 17 x 22 and 18 x 22 cylinders. We noticed that upon a number of those standing in the round-house ready for service, the Griggs method of fastening tires is employed, and as we were told, with entirely satisfactory results. Most locomotive builders are doubtless familiar with this method, but so far as we have observed, it is used to quite a limited extent. There are dovetailed projections on the wheel a little over an inch in height, and about five inches apart; the tire fits loosely around these, and is brought to a bearing by driving into the spaces between the projections, blocks of hickory wood boiled in linseed oil until the sap is expelled. Thin wedges of wood are also driven between the dovetailed projections and the tire, so that the bearing is entirely upon the wood, which is, of course, the same width as the tire. The introduction of this elastic element has the effect of deadening the jar to an appreciable extent, and is so far an advantage to both engine and track.

The Mansfield Frog is another application of the same principle, and is in use on this road. The frog proper, consisting of the rail-pieces, heel-block, and point, is supported upon a foundation of three plates of iron, with two intermediate layers of wood, one 1½ and the other 2 inches in thickness, which together form a susbtantial foundation, with sufficient elasticity to lessen the injurious effects of the continuous pounding.

[American Railroad Journal.]

RAILROADS OF THE UNITED STATES, JANUARY 1, 1876.

THE first railroad built in the United States was the Granite Railroad, connecting the quarries in the town of Quincy, Mass., with the Neponset River, a distance of about three miles. It was chartered March 4, 1826, and opened for use in April, 1827. The purpose of this road was patriotic, its main object being the supply of granite for the Bunker Hill Monument. Three years later several other roads were partially completed, and the reign of the locomotive steam-engine inaugurated. Among the first steam roads opened were the Baltimore and Ohio, the South Carolina, and the Mohawk and Hudson, portions of which were operated by steam-power in the latter half of the year 1830. The total mileage in operation at that date was about forty miles. In the decade 1860–'70 the increase of railroads measured 20,000 miles, and at its close we could count 48,860 miles. At this date we were building at the rate of 5000 to 6000 miles a year, and the rate was maintained to the fall of 1873, when the September money-panic occurred, which speedily arrested the work in hand and brought financial ruin to several of the great works then in progress. During the last two years (1874 and 1875) construction has been almost suspended, except on lines of immediate necessity and well supported by foreign capitalists. There has, however, been a large amount of work done in improving and completing existing great lines, and laying down additional tracks for the accommodation of their growing business. But all further awaits the return of more prosperous times.

The year 1876—the Centennial of the Nation's birth—finds us with a network of railroads extending from the Atlantic to the Pacific, and from the great lakes to the Gulf of Mexico. The length in operation January 1, 1876, is 76,756 miles, and to this must be added for double-tracks and sidings 14,861 miles—making the entire track in use 91,617 miles. The cost of this congress of railroads has been $3,941,383,197, or at the rate per mile of line of $51,369.

In this category we do not include the properly called industrial railroads, or those used solely in mines and factory districts. These are private roads, generally of short length, and not used for the public transportation of persons and merchandise. In the aggregate, however, these are important, and would add materially to the length if reported among the commercial roads of the country.

Neither do we include the city passenger railroads. These also would add largely to the aggregate. They are now in operation in every city and town of importance, and also in country places were population and work-shops are unusually distant from each other. In all cities and other places where they are used, urban and sub-urban passenger-cars have become indispensable to the economy of the business as well as of the domestic interests of the inhabitants. Probably the whole length of city line now built exceeds 2000 miles.

Among the communities which have most distinguished themselves in railroad construction during the year 1875, are the States of California and Nevada, and the Territory of Utah; also the States of New-Jersey, New-York, etc. In the first named the narrow-gauge roads have been wonderfully developed, and appear to have been very successful, especially in the more mountainous districts. The longest of these, and the longest, with one exception, in the United States, is in Nevada—the "Eureka and Palisade"—which has a length of ninety miles. The "Denver and Rio Grande" alone exceeds this in length, extending, as it does, from Denver to Pueblo, 120 miles, with a branch to Carson City of 43 miles. In other parts of the Union the narrow-gauge railroad has been more slowly adopted; but in several States a considerable mileage has been already built, and in nearly all new lines have been projected.

It would be impossible to note with accuracy the amount of rolling stock in use on the railroads in operation. An attempt in this direction, however, has been made, and with the following results:

Sections.	Locomotives.	Cars. Pass.	Freight.	Other.	Total.
N. E. States	1,579	2,417	29,120	1,322	32,859
Middle States	4,873	5,591	164,509	2,713	173,806
So. E. States	1,107	1,371	12,897	922	15,090
Gulf and S. W. States	1,309	922	16,102	797	17,821
Interior, E.	5,040	3,560	112,909	1,872	117,701
Interior, W.	1,690	1,970	29,300	1,400	31,970
Pacific, etc	597	265	5,980	475	6,720
Total	16,194	15,396	370,170	9,501	395,967

This enumeration, in the total, gives to each one hundred miles 21.10 locomotive-engines; 19.08 passenger-cars; 482.27 freight-cars, and 12.39 other (construction, working, repair, etc.) cars. The total of all cars is 513.74 to the hundred miles.

More in this country than in any other the convenience and safety of railroad locomotion have been studied and utilized. To the perfection of these prerequisites of highest benefit to the world, inventive genius has been directed with such great success that accident to trains is scarcely probable. The substitution of steel for iron in the rail, and the improvement in mechanical appliances for the movement and transfer of trains, have conduced to a wonderful accession to safety. Where danger is latent the telegraph discloses it with intelligence and dispatch. The duplication of tracks on the great lines is progressing rapidly, and ample means by turnouts, sidings, etc., are largely and increasingly provided. With regard to rolling stock, great safety is acquired by means of patent brakes of various kinds, so that moving trains can now be stopped almost instantly, and collision be modified or altogether prevented.

Among the inventions included in this category, we may mention as being the most efficient in their kind, the "Miller Trussed Platform," with compression buffers and automatic couplers, and the "Wharton Safety Switch." The first-named reduces concussion where an accident has occurred to a minimum force, and entirely prevents that most dreaded occurrence known as the "telescoping" of the cars in train. The Wharton Switch is also automatic in its operation, and is sure to preserve a clear connection between diverging tracks. Both these valuable inventions are in use on many of the great roads of the country, and have proved to be perfect in their design and execution.

These and other inventions speak well for American genius, which has conquered so many difficulties, and which is destined in the future to greater successes. There is yet much to be accomplished in this direction, and the requirements of pleasant and safe locomotion are increasing with the progress of æsthetic civilization. The best test of the high perfection to which the railroad and its moving engines have been brought in America, has been the acknowledgment by the world of the grand results, and their adoption by all civilized nations. Bessemer steel we owe to Europe; but the various brakes, the automatic couplers, the safety-switch, the palace and hotel-cars, the sleeping-car, and many other of the conveniences of travel and transportation, are American.

Here, as in all other countries, the railroad has worked a wonderful revolution. It has built up an empire beyond the Alleghanies in much less than the third of a century. It has developed a savage country, which is now overspread by a civilized population counted by millions, and an internal and external commerce of vast dimensions. Many cities that had no existence fifty years ago, or even twenty-five years ago, are now counted among the largest, most industrial, and wealthy in the world. Cincinnati, St. Louis, Chicago, etc., are apt illustrations; and on the far Pacific shore, San Francisco. In manufactures and commerce, each of these vies successfully with cities that count their ages by hundreds of years. In the manufactures connected with railroads, though now under a passing cloud, immense numbers of men are employed, and vast millions of money are invested. The mining of coal, commenced fifty years ago, is now immense, and the product used largely on railroads and in the manufacture of iron. The annual product has reached 45,000,000 tons, of which one half is anthracite and one half bituminous. About 2,000,000 tons of iron are produced, and the other useful minerals in large and increasing abundance. That this change in circumstances is due chiefly to the railroad is obvious; as since its introduction as an instrument of progress, the general industry of the civilized portion of the world has been multiplied ten times. A few facts in relation to the United States, and their progress under the sway of the railroad, will demonstrate this great fact:

	1830.	1873.
Railroads (miles)	41	76,756
Settled area (square miles)	630,000	1,950,000
Population	13,866,000	40,000,000
Urban population	864,000	8,350,000
Exports to foreign countries	$59,462,000	$329,132,100
Imports from foreign countries	$40,575,000	$550,556,700
Coal produced (tons)	625,750	45,000,000
Iron produced (tons)	300,000	2,000,000
Cotton (bales)	1,000,000	4,500,000

This table shows grand results. In 1830 it cost as much time and money to transport a passenger or ton of freight to Buffalo as it now does to transport these units to San Francisco! In fact, there was at that date little intercourse between the East and West—the whole interchange being then by canal, earth-road and natural water-ways, as lakes, rivers, etc. Beyond the Alleghanies population was sparse and almost isolated. Not a railroad existed in all the western country. Buffalo, Pittsburg, Cincinnati and St. Louis were small but important places. Chicago had not commenced its career. St. Paul was a myth! San Francisco the seat of a Catholic mission! Multitudes of men yet living can bear witness to these facts. They have watched the wonderful progress and noted the result.

In England the public railroad commenced its career in 1825, just half a century ago. The chief actor in its creation and utilization was George Stephenson; and the scene, Darlington. On the 27th of August of the year named, the Stockton and Darlington Railroad (23 miles) was opened for traffic. The semi-centennial of this event was celebrated with great *éclat* in August last, and was participated in by all the great lights of railroad life. Many, who at that early day had scoffed at the idea of steam travel and transportation, were there to rejoice that their adverse auguries had been frustrated, and make just acknowledgment of the fact that the railroad was a success.

With regard to the railroad prospects of the nascent year, it is not wise to predict. We have already passed through a two-years' period of stagnation in railroad-building. In that brief period much, however, has been done towards recovery from the pressure of the financial spasm of September, 1873; and companies having reorganized their affairs will be better able to cope with difficulties and go ahead. Abundance of money and cheap labor have already asserted their powers, the effects of which will probably lead to results that otherwise could not be attained. Good speed to the railroad and its friends!

[Iron.]

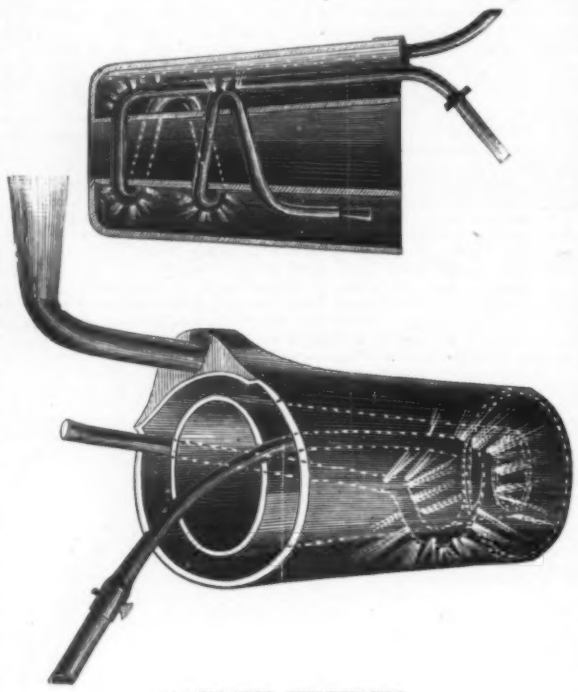
SAFETY TUYERE.

IN the two years, 1859 and 1860, the newspapers recorded no less than four fatal explosions, resulting in nine deaths, besides injuries short of death to a still larger number, and great destruction of property, all occasioned by leaky and defective blast-furnace tuyeres. Since that time, though there are no accurate statistics available, it is probable that at least forty lives have been lost from the same cause, and that these fatalities have been attended by a proportionate damage to property and limb. And besides these more serious disasters, to which inquests give some sort of publicity, there are constantly accidents happening from a similar cause, of which nothing is heard, beyond the limits of the works at which they occur. Yet it has been truly said that, without the water-tuyere, the hot-blast would have remained till this day an impracticable invention. We can not give up the water-tuyere, but it remains to be seen if it can not be rendered safe.

The tuyeres at present in general use are the Scotch tuyere and the Staffordshire tuyere. In the former, a spiral tube of wrought-iron is imbedded in the solid casting of the tuyeres; and a stream of water passes continuously through this tube. The Staffordshire tuyere consists of a hollow truncated cone of wrought-iron with double walls, through which the water circulates. Perhaps, on the whole, the Scotch tuyere is the safer, though less durable, but it by no means approaches adequate security.

As Dr. Percy himself is somewhat uncertain as to the precise antecedents of a tuyere explosion, it can hardly be said that more is known on the subject than that it results from the tuyere water coming into contact with the molten metal in the hearth, followed by the sudden generation of an immense volume of steam (which would very probably be simultaneously decomposed). Percy inclines to the belief that a rising of the furnace-hearth is generally the proximate cause of this kind of accident. Mr. Menelaus, of Dowlais, however, thinks that no explosion takes place without some portion of the melted tuyere falling into the bath of metal, and carrying water down with it under the surface. This view he supports by quoting the fact that, while water alone may be thrown on fused metal with impunity, the presence of a pebble or fragment of solid iron with the water will often cause a violently explosive eruption of the metal.

Now, as the temperature of blast is being increased year by year, and has already attained in common practice to a point very far superior to any thing dreamt of fifteen years ago, the importance of improving on the ordinary tuyere becomes daily more urgent. With a blast of from 700° to 1400° Fah. the tendency of the tuyere to suddenly give way before the intense heat to which it is exposed, becomes a matter for the most anxious precaution; while even if explosions are avoided, the necessity for frequent repairs of tuyeres with the inevitable consequent disarrangement of the furnace-economy, becomes a serious inconvenience.



SAFETY TUYERE.

It has been said by experienced ironmasters that leakiness is the chronic condition of the ordinary tuyere, and as the introduction of even a small quantity of steam into the furnace distinctly lowers the temperature, with consequent waste of fuel and production of white iron, a tuyere which will not leak is evidently a desideratum.

The open spray tuyere, contrived by Mr. Lloyd, of Wednesbury, appears to promise well, and to be a marked advance on the existing patterns of tuyere. The cooling is effected by the introduction of a perforated pipe within the hollow walls of the tuyere, as shown in the accompanying illustrations. Water being admitted into this pipe, under a moderate head, a number of little jets of water play on the heated surfaces of the casing, and, even when the tuyere is exposed to the highest temperature, by their partial or entire evaporation, effectually reduce its temperature and keep it from being overheated. The water passes off by a pipe from the lower side of the tuyere, and is no warmer than the waste-water from an ordinary water-jacketed or coiled tuyere. The back part of the casing is open to the atmosphere.

Now this arrangement appears to offer considerable guarantees for security from explosions under almost any circumstances. In the first place, a jet of water thrown on a heated surface will cool it more effectually than the mere circulation of a current of water through a mass of metal; since for every unit of water vaporized some 530 heat-units are abstracted from the heated surface on which it impinges. But even assuming that the end of the tuyere were partly melted off, no considerable body of water would find its way into the furnace, but only a few sprays which would harmlessly dissipate into steam and prevent the melting from going further. The fact of the outer end of the tuyeres being left open also prevents danger arising from the rapid formation of steam in the casing of the tuyere itself, as an explosion can only take place under very exceptional circumstances indeed, when there is no restraint imposed on the expansion of the evaporized water.

The Lloyd spray-tuyere has been in use at the Darlaston Iron and Steel Company's furnaces for more than a year, and is now being adopted at over thirty furnaces, including Earl Dudley's furnaces, the Willingsworth Iron Company, Mr. J. H. Pearson's, Messrs. Hingley's, the Airside Hæmatite Iron Company, West Cumberland Iron and Steel Company, Deepfields Iron Company; Mr. A. Hickman's, Spring Vale Furnaces; Messrs. J. Colbourn, Sons, and Company, and the Wellington Coal and Iron Company, where the tuyeres have been in use a considerable time. It is said to have proved as durable as the most long-lived of its predecessors, and to possess the advantage of being safe to work with till it can be conveniently replaced; even after the casing has become defective. It is, however, as offering a reasonable protection against one of the most serious dangers that beset the arduous labors of the furnace-tenders, that Mr. Lloyd's contrivance most demands attention. If it prove to be indeed a *safety* tuyere it will take rank as an invention which deserves well of the metallurgical community.

[The Agricultural Gazette.]

FARM WEEDS.

THE BUTTERCUP.

IT will be seen that the distinguishing character of the Ranunculus repens (Creeping Buttercup) is its habit of increasing by scions, which root above the ground like the so-called runners of the Strawberry, and though there are other weeds that act in this manner, we must for the present leave them in order to complete the weed history of the Buttercups. It will have been seen that the R. repens, though so common and mischievous as an arable weed, is really derived from the meadow; there is one other agrarian form, namely, the R. arvensis, which is at once distinguished by its position—being only in the cornfield—and its small, pale, yellow flowers, followed by large seeds (achenes), armed with hooked spines.

FARM WEEDS.—THE BUTTERCUP.

It is very general in cold poor clay arable fields, from which it never strays to any semblance of pasture. It is considered such strong evidence of poor clays as to have got for it the name of "hunger weed" in the western and midland counties. The real home of this plant seems to have been Asia, whence it has doubtless been distributed with seeds, and hence it is that it only tracks agrarian cultivation in England.

It is considered to be a very acrid poison, so that where it occurs in any quantity it may be well to look after cattle or sheep that have a chance of feeding upon it, as it is stated that they feed greedily upon it. We extract the following note upon its action on sheep from the new edition of *English Botany*: "Near Turin several sheep were killed by eating it, which first led to an investigation of its effects. Colic, with inflammation of the stomach, were the symptoms, which were best removed by pouring vinegar down the animals' throats. The poison seems to act in paralyzing the nerves of the stomach, and also in an acrid, ulcerating effect, as dark spots were found in the stomach of the sheep."

The best way to get rid of it is not to sow it, which is often done in corn. If, however, seed-corn be obtained from lighter soils, its introduction in this way would be very unlikely. If already in a field, the corn there grown should be carefully hoed, as the pest is sure to seed before the corn is ripe. Good cultivation is indeed its great discourager, and this involves care in preparing the soil, in selecting the seed to be sown upon it, and care in after-weeding.

The Buttercups we have now to consider are pre-eminently those of the pasture-field, which from their bright yellow colors were once supposed to be concerned in giving the rich yellow color to butter, and hence their common names. Of these we have two sorts, namely:

Ranunculus bulbosus, with ribbed stems, reflexed calyx, and especially its bulboid root stock, which latter has got it the local name of St. Anthony's Turnip. These bulbs contain a quantity of starchy matter, and are sometimes eaten by greedy boys, but we do not recommend them. This is one of the commonest plants met with in comparatively sound and dry meadows. Its herbage is occasionally eaten by cattle, but usually to a very small extent, which is as well, as it can not be considered other than as an acrid plant, and not healthy for cattle in its green state. In the hay, though its acridity is much modified by drying, yet even if harmless it can only be considered as a diluent, taking much from the quality of the produce.

It is then to be discouraged, and this is best done by whatever will encourage the growth of the true grasses, whilst on the contrary whatever tends to the opposite will certainly increase the weed. Thus too much greed for the rick, and especially letting the grass be cut late, will impoverish the pasture, and so cause the seeds to be sown in congenial soil.

On the contrary, thickly depasturing with cattle and sheep will tend very much to keep it down, and in hay-making the earlier it be done the better, as then the hay will be of finer quality and the aftermath will not be likely to be so much affected with the Buttercup. Top dressing of road rubbish, scouring of ditches, and the like, will at the same time greatly aid in improving the grasses, and consequently in discouraging all extraneous plants.

The Ranunculus acris (Upright Buttercup) has next to be considered. Its stem is perfectly rounded, and a little armed with short hairs. It has deeply divided leaves, and is rather a denizen of the moist than of the dry meadow. Indeed, it is common, too much so, to our richest lowland or river pastures. The rich river flats, as on the Yeo and the Parret in Somerset, often look unpleasing from the ragged masses of the Upright Buttercup, which grow and flower, while all the rest of the herbage is eaten down to the ground, thus affording tolerable evidence that this plant is rightly named Ranunculus acris, and there can be no doubt that it is exceedingly acrid, so much so, indeed, that cattle rarely touch it, and though it can be kept down by thickly depasturing with sheep, there is much risk in killing some of them with inflammation of the bowels. Like the preceding, it can be discouraged by judicious cultivation; drainage, irrigation, sheep-folding, and whatever tends to a more exclusive growth of good grasses, much discourages the Buttercup. When hay is made, it should always be cut as early as may be before the Buttercup seeds ripen, as then no new seed is sown, and the hay and the aftermath will always be of better quality.

The Ranunculus ficaria (Celandine Crowfoot, lesser Celandine, Figwort, or Pilewort) is not uncommon to pastures and hedge banks; it is distinguished by heart-shaped leaves and roots, like little figs. It comes so early into flower, and its leaves, which are close to the ground, die so soon, that, though the plant is very acrid, it never finds its way into the rick; still, where it exists in quantity, it is a troublesome weed, as it takes up space that might be better occupied. Heavy sheep-folding very early in the year, with a view to treading rather than feeding, which latter should be done with such meadow hay as could not be cut until late, will prevent its seeding and even leafing, and has been found a sure method of getting rid of this weed. Indeed, it will be seen with the whole of these weed pests that good cultivation is their bane, and as they are at best perfectly useless for cattle food, in which there is reason to think that most, if not all, the species are more or less poisonous, their almost exclusively taking up the pasture, as is sometimes the case, shows a great want of care and attention. Indeed, weeds in pasture show slovenliness, as much as weeds in the arable.

FRENCH STREET TRAMWAYS.

FROM the official report of M. Rousselle, the engineer-in-chief, we gather the following particulars as to the present state of street tramways in the department of the Seine. Of the 133,914 metres—83 miles—of tramways for which concessions have been granted, 47,114 metres—29 miles—are completed and in work, and 30,300 metres—19 miles—in course of construction, leaving 56,500 metres—35 miles—at present in abeyance. The lines completed and in construction are divided between three companies—the Omnibus Company, the Northern Tramways Company, and the Southern Tramways Company; the latter have, however, no line as yet in operation. The Omnibus Company adopt tram-cars with a pole, having *impériale* or seats on the roof, and a platform in the rear. The coachman is mounted on a box like that of ordinary carriages, and works the brake. The tires of the wheels on one side of the car only are provided with flanges, so that getting off the track is not a difficult matter. At the extremities of the route the cars have to be turned round by means of rails laid in the form of a ring. At first this operation was performed with great difficulty, but now both drivers and team accomplish it with ease and rapidity. The Northern Tramways Company make use of low but not inelegant cars, without *impériale*, pole, or shaft. First-class passengers are accommodated with seats in a closed compartment, while those of the second class have to remain standing on the platforms at each end of the car. The horses are harnessed by traces only to either end, according to the direction; the driver is placed on the front platform, and the conductor in the rear. All the wheels have flanged tires, so that leaving the rails is not a matter of frequent occurrence and is only due to some accident. On the 29 miles now in operation the number of passengers each day is 67,000, or 230 per mile per day; this gives 191,000 passengers daily for the whole system when complete, a figure which, however, will probably be exceeded.

THE INTERNATIONAL EXHIBITION OF 1876.—ELEVATION OF THE MACHINERY HALL.

THE INTERNATIONAL EXHIBITION OF 1876—THE MACHINERY BUILDING.

THIS structure is located west of the intersection of Belmont and Elm avenues, at a distance of 542 feet from the west front of the Main Exhibition Building, and 274 feet from the north side of Elm avenue. The north front of the building will be upon the same line as that of the Main Exhibition Building, thus presenting a frontage of 3824 feet from the east to the west ends of the Exhibition Buildings upon the principal avenue within the grounds.

The building consists of the Main Hall, 360 feet wide by 1402 feet long, and an annex on the south side of 208 feet by 210 feet. The entire area covered by the Main Hall and annex is 558,440 square feet, or 12.82 acres. Including the upper floors, the building provides 14 acres of floor space.

The principal portion of the structure is one story in height, showing the main cornice upon the outside at 40 feet from the ground, the interior height to the top of the ventilators in the avenues being 70 feet, and in the aisles 40 feet. To break the long lines upon the exterior, projections have been introduced upon the four sides, and the main entrances finished with façades, extending to 78 feet in height. The east entrance will form the principal approach from street-cars, from the Main Exhibition Building, and from the railroad depot. Along the south side will be placed the boiler-houses and such other buildings for special kinds of machinery as may be required. The west entrance affords the most direct communication with George's Hill, which point affords the best view of the entire Exhibition grounds.

GROUND PLAN.

The arrangement of the ground plan shows two main avenues 90 feet wide by 1360 feet long, with a central aisle between and an aisle on either side. Each aisle is 60 feet in width; the two avenues and three aisles making the total width of 360 feet. At the centre of the building is a transept of 90 feet in width, which at the south end is prolonged beyond the Main Hall. This transept, beginning at 36 feet from the Main Hall and extending 208 feet, is flanked on either side by aisles of 60 feet in width, and forms the annex for hydraulic machines. The promenades in the avenues are 15 feet in width; in the transept 25 feet, and in the aisles 10 feet. All other walks extending across the building are 10 feet in width, and lead at either end to exit-doors.

CONSTRUCTION.

The foundations consist of piers of masonry. The superstructure consists of solid timber columns supporting roof trusses, constructed with straight wooden principals and wrought-iron ties and struts. As a general rule the columns are placed lengthwise of the building, at the uniform distance apart of 16 feet. The columns are 40 feet high to the heel-block of the 90 feet span-roof trusses over the avenues, and they support the heel of the 60 feet spans over the aisles, at the height of 20 feet. The outer walls are built of masonry to a height of 5 feet, and above that are composed of glazed sash placed between the columns. Portions of the sash are movable for ventilation. Louvre ventilators are introduced in continuous lengths over both the avenues and the aisles. The building is lit entirely by side light, and stands lengthwise nearly east and west.

SHAFTING.

The building admits of the most complete system of shafting, the facilities in this respect being very superior. Eight main lines may be introduced, extending almost the entire length of the structure, and counter-shafts introduced into the aisles at any point. The hangers will be attached either to the wooden horizontal ties of the 60 feet span-roof trusses, or to brackets especially designed for the purpose, projecting from the columns, in either case at the height of 20 feet from the floor.

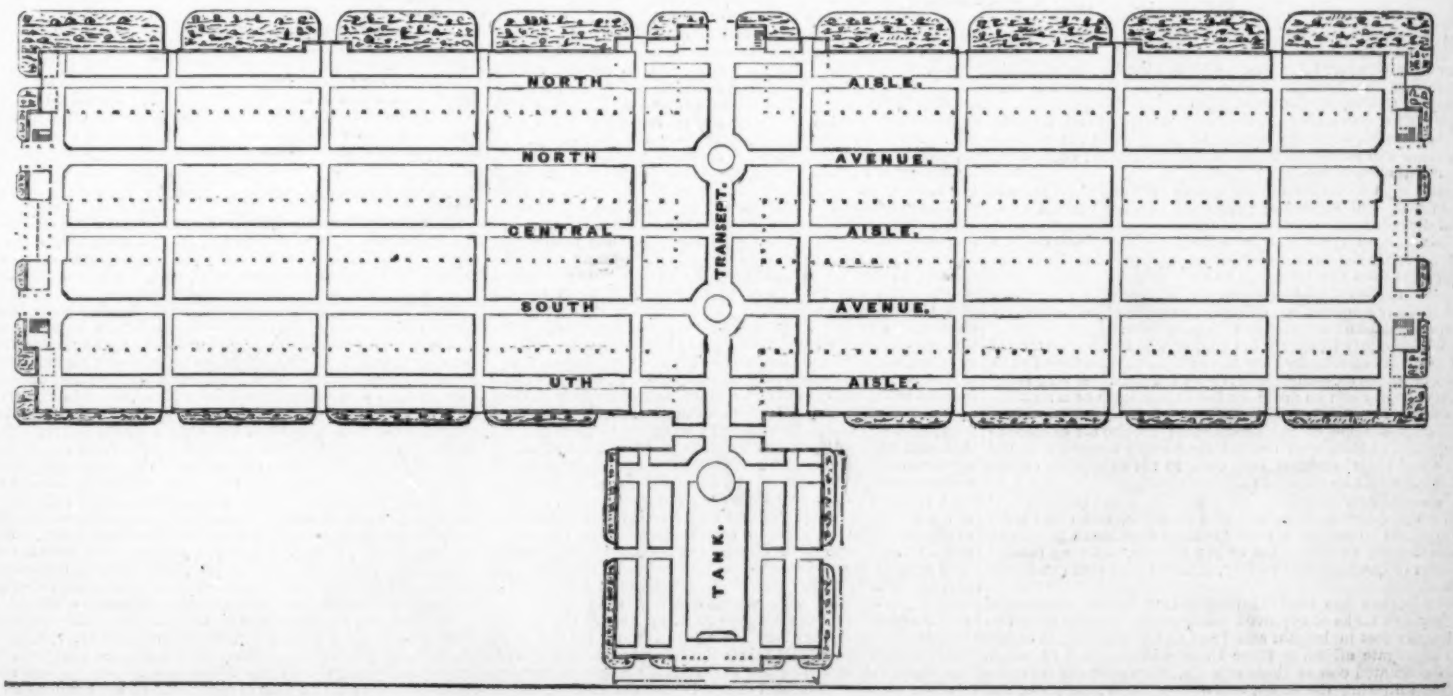
HYDRAULIC ANNEX.

The annex for hydraulic machines contains a tank 60 feet by 160 feet, with depth of water of 10 feet. In connection with this it is expected that hydraulic machinery will be exhibited in full operation. At the south end of this tank will be a waterfall 35 feet high by 40 feet wide, supplied from the tank by the pumps upon exhibition.

[National Car-Builder.]

CENTENNIAL DEPOT.

THE plans for the Pennsylvania Railroad Company's new temporary depot, for the accommodation of Centennial visitors by the trains on that line, are completed, and work on the proposed building will soon be commenced. The new depot will be 650 feet long and 100 feet wide, located on the west side of Elm avenue, opposite the main entrance to the Exhibition. The tracks will be laid in the shape of a circle, which will be 1000 feet in diameter. Three tracks will be laid round this circle, which will be used respectively for arriving and departing trains from the east, west, and south—trains from all points running direct to the Centennial grounds. They will be switched upon their respective tracks composing the circle, stopping in such a way as not to overlap each other, and discharging or receiving passengers at long, covered platforms, running continuous to the depot entrance. Trains which do not depart immediately after their arrival will go round the circle and be backed upon some one of the fourteen sidings which will be built on the north of the main tracks. The engine will head east, and will not leave its train, but at the proper time for departure will be again put upon the circle. Departing trains will always reach the main track from the circle headed in the direction they are to proceed.



THE INTERNATIONAL EXHIBITION OF 1876.—GROUND PLAN, MACHINERY HALL.

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[Shoe and Leather Reporter.]

THE LEATHER EXHIBITION BUILDING.

THE building for the special exhibition of leather and its products has been contracted for; it will be 160 feet front and 314 feet deep. In shape it will form a parallelogram. The materials to be used will be wood mainly, with glass and iron also. The façade of the building is two stories in height, with gently sloping roof with three peaks, the centre one the highest, overhanging an ornate oriel window, each point of the roof supporting a flagstaff 80 feet high.

The interior of the building presents an open space 256 feet long and 160 feet wide. The roof is supported by columns 16 feet apart, the central section being a curve 80 feet wide, of the Howe truss pattern, over which is a Louvre ventilator 20 feet wide, running the length of the building 60 feet above the ground. The pavilions are 20 and 30 feet high. The ground floor of the building is divided as follows:

An aisle 15 feet wide and 300 feet long runs through the centre, and on either side is one 10 feet wide, parallel with the centre aisles. Across the centre of the building is a passage-way 10 feet wide, at either end of which is a doorway leading to Machinery Hall on the north, and Elm avenue on the south. The east and west sections of the ground floor have aisles 14 feet wide. There are eight main exhibition spaces for exhibits (bounded by the aisles) 20 feet 6 inches in width and 117 feet in length; and four exhibition spaces of 12 feet in width by 114 feet in length.

On the right and left of the main entrance to the building are stairways leading to the second floor, in front of which, through the width of the building, is placed a gallery, 8 feet wide and 112 feet long. From this gallery an unobstructed view of the whole building is obtained. A hall 16 feet wide divides the second story into two parts, and leads to a balcony facing Belmont avenue, giving a commanding view of Machinery Hall, Memorial Hall, Main Building, and the concourse approaching the Exhibition grounds. On either side of the hall is a ladies' and gentlemen's parlor respectively, 16 feet by 33. The first floor is divided into waiting-rooms, reading-rooms, register-office, wash-rooms, etc.

The second story in the rear of the building is partitioned for offices. Provision is made to introduce shafting, drainage, water supply, gas, etc. The columns supporting the roof are constructed in such a manner as to be connected by iron rods, from which sides of leather, goatskins, sheepskins, Russia leather, etc., can be suspended, so as to facilitate examination by juries of award and inspection by visitors.

The spaces will be mostly arranged with artistic cases for the display of gentlemen's, ladies', misses' and children's shoes and all kinds of leather fabrics.

Packages and shoe machinery can be delivered at the doors of the building by railroad. The central station of the city passenger railroad is within a hundred yards of the main entrance of the building, and altogether the location is a most desirable one.

THE EXHIBITION OF FISH AT THE CENTENNIAL.

CAPTAIN BURNET LANDRETH, Chief of the Bureau of Agriculture, has issued the following circular with regard to the display of fish at the Centennial Exhibition:

SIR: The Bureau of Agriculture, International Exhibition, is charged with the display of all foods in the various conditions and processes of management of wild, cultivated, and manufactured forms.

Under such a comprehensive system is included an exhibition of fish, both alive and preserved in their various commercial conditions.

It is admitted by all who have made a study of fish culture that food can be much more cheaply produced from the water than from the land, and to familiarize the people with the best food-producing species of fish, and the appliances used in their propagation, culture, and capture, will certainly be the pleasure of all friends of pisciculture.

To thoroughly illustrate the vast extent and importance of fish foods, it is necessary that the exhibition of living fish in tanks be made as comprehensive as possible. A very satisfactory display can be made by the expenditure of a sum insignificant as compared with the interests involved.

The regulations of the Commission require all exhibitors to provide at their own cost all show-cases necessary to the display of their products, and even in the exhibition of fish these rules will be adhered to.

Fish-breeders, however, have not the same incentive to make a display as have breeders of cattle, and can hardly be expected to assume a corresponding expense in providing apparatus for an exhibition of six months. If they furnish the fish in quantity and variety, it may be all that can be expected.

The Bureau has received propositions for the erection of twenty-five tanks of approved construction, ranging from two to twenty feet in length, and from one to six feet in depth, the aggregate affording three thousand cubic feet of water. The estimated cost of these aquaria, the apparatus for erecting and filtering the water, cost of freight in specimens, and cost of attendance, amounts to $6000.

The Bureau is promised from responsible parties constant supplies of both fresh and salt-water fish, the list ranging from the smallest minnow as stock food, to sharks and porpoises of largest size.

To make this exhibition a success will you present this circular and the accompanying form to such parties of your acquaintance as would be favorably disposed to contribute to this purpose by the purchase of one or more ten-dollar shares of Centennial stock, the money, though going into the general fund, to be understood as contributed to the fish exhibition.

Very respectfully,

BURNET LANDRETH,
Chief of Bureau of Agriculture.

JOHN WELSH, President Centennial Board of Finance.

[Carriage Monthly.]

CENTENNIAL BUILDING FOR THE DISPLAY OF CARRIAGES.

THE contract has been awarded for the erection of the building for the display of carriages at the Centennial Exposition for $53,000. The building will be commenced after the 1st of January, and will be ready before the opening, the 10th of May.

Those who have not made application for space, and who expect to exhibit, should do so at once, as it is uncertain how much space there is vacant.

CENTENARIANS IN NEW-YORK.

A LATE number of the New-York *Tribune* says: "The list of centenarians living in the State last June is extracted carefully from the census tables, prepared by Secretary of State Willers, but may possibly yet be subject to revision. The total number of those 100 years old and upward is 109, a gain of 19 over the census of 1865, when there were 91 centenarians in the State. The natural increase of the population, and possibly a Centennial spirit engendered by the time, may account for this gain, which ought at least to indicate that the race is not degenerating. In an analysis of the table, it will be seen that forty of the one hundred and nine were born in Ireland, six in Canada, two in England, two in the West-Indies, one each in Scotland, Spain, and at sea, while thirty-five are natives of the United States, and twenty remain unrecorded, either through errors of the enumerators, or possibly because it was too long ago to remember. Twenty-nine of these venerable people live in New-York City, twenty-two of these having been born in Ireland, and only two in New-York City. The oldest one mentioned is Sarah Hicks, of Brooklyn, who is 114, while a resident of the same city, Isabella Simpson, and several others, reach 110. Brooklyn, indeed, seems to be much healthier to old people than New-York City. There, the oldest one mentioned reaches only the comparatively youthful term of 109. The gentler sex show the greatest degree of longevity, not only counting the very oldest on their side, but numbering twenty-seven more than the ruder and stronger sex. Mitchell Swearingen, of Franklin County, who is 101, has a wife who lacks only four years of the age necessary to secure the record of her name in the list. There are twelve colored persons and two Indians in the list.

PROCEEDINGS OF SOCIETIES.

AMERICAN GEOGRAPHICAL SOCIETY, NEW-YORK.

THE American Geographical Society held its annual meeting at Chickering Hall, January 11th, Rev. Roswell D. Hitchcock presiding. The report of the Council was read, giving an account of the proceedings of the Society for the past year. The Treasurer's report showed the receipts to have been, including the balance of last year, $9207.80; disbursements, $7776.91.

Charles P. Daly was elected President.

The Chairman introduced the lecturer of the evening, Mr. S. Wells Williams, LL.D., for many years the Secretary of the American Legation at Pekin, who delivered an interesting address on "China, its Geography, People, and Relations to Other Nations."

After describing the peculiarities of the geographical structure of the country, its watercourses, climate, etc., the lecturer proceeded to speak of the Government. The Emperor, he said, styles himself the Son of Heaven, and relegates to himself a position almost divine, and claims that he, and he alone, should worship heaven and earth. He has two temples, one of heaven and the other of agriculture, and to one of these he goes once a year to worship, attended by a numerous retinue. There are no priests and no religion: it is state worship, and the Emperor, being the only one who can worship heaven in this way, has prevented all hierarchs and all priesthood coming between him and the object of his worship. The Emperor has the power over life and death, but practically he deputes this power to subordinates, who are chosen by a singular mode, compared with other nations. The mode of electing officials in China is by a series of competitive examinations, and the way in which it is done can be briefly told. Throughout China the common schools are supported entirely by the people; the State has nothing to do with them; and as soon as a man is conversant with the classics, as they are called, he can go to the Superintendent of Education and propose to be taught; and when he has gone through this examination, he goes at a stated time to his district city and is instructed by a person appointed by the Government, and from this he goes to the perfect city and has an examination in the same way—that is, by writing an essay. He is given a text and writes an essay upon it, and from this he goes to the capital of the province, and there he is enabled once in three years to enter for an examination for the second degree. The examination hall of Canton contains about ten thousand little cells, so small that you can neither stand up nor lie down in them, and every person is accommodated with a chair, and is obliged to sit at a little table, and is furnished with pen and paper, is given a theme to write upon, and out of ten thousand candidates that may come to have their essays examined, only seventy-two can be successful; the others must remain without a degree until the next examination. The essays are submitted to the Chancellor of the Province, and his task is to say which are successful. I don't think that there can be a more wearisome task than to examine 10,000 essays, all written upon one theme and in the Chinese language. First, they look the essay over and see if a single word is spelt wrong. If this is the case, it goes out, and no amount of talent will suffice to save it if a single character is written wrong. The third degree is given at Peking, and out of 12,000 candidates only 200 can be successful, and none can enter for the third degree unless they have passed the second. And in this way the officials are chosen.

LONDON MATHEMATICAL SOCIETY. LONDON, DECEMBER, 1875.

PROFESSOR H. J. S. SMITH, F.R.S., President, in the chair.—Professor Clifford read a paper on "The Transformation of Elliptic Functions," in which he attempted to apply Jacobi's geometrical representation of the addition theorem in elliptic functions to the theory of their transformation. Professor Cayley spoke on "A System of Algebraical Equations connected with Malfatti's Problem." The chairman communicated three notes: 1. "On a Problem of Eisenstein's" (to determine the cases in which the equation $Z = Y^2 - (-1)^{\frac{1}{2}(p-1)} p X^2$ admits of a multiplicity of solutions, and to ascertain the law connecting the various solutions, when there is more than one); 2. "On the Joint Invariants of Two Conics or Two Quadrics;" (3) "On the Equation P × D = constant of the Geodesic Lines of an Ellipsoid." A brief abstract of this last may be of interest. Let Q be the point where the two geodesic tangents intersect at right angles; O the centre of the ellipsoid; let $c = OQ$, and let $a\,b$ be the semi-axes of the central section parallel to the tangent plane at Q. The two geodesics make angles of 45° with the lines of curvature at Q: hence for either of these geodesic lines, $D^2 = \frac{2a^2b^2}{a^2+b^2}$. Let Q′ be a second point where the geodesic tangents to the same line of curvature intersect at right angles; then $\frac{2P^2a^2b^2}{a^2+b^2} = \frac{2P'^2a'^2b'^2}{a'^2+b'^2}$, because P × D has the same value for all geodesic lines, touching the same line of curvature. But $P^2a^2b^2 = P'^2a'^2b'^2$, because parallelopipeds circumscribing an ellipsoid with their faces parallel to conjugate diametral planes are equal. Hence $a^2+b^2 = a'^2+b'^2$; but also $a^2+b^2+c^2 = a'^2+b'^2+c'^2$ ∴ $c = c'$, and Q and Q′ lie on the same sphero-conic. Mr. Tucker (Hon. Sec.) communicated a paper, by Mr. H. W. Lloyd Tanner, "On the Solution of Certain Partial Differential Equations of the Second Order, having more than Two Independent Variables."

ROYAL ASTRONOMICAL SOCIETY. LONDON, DECEMBER, 1875.

PROFESSOR ADAMS, President, in the chair.—A paper was read by Mr. Burton on the supposed changes of the nebulæ of η Argûs, and 30 Doradûs, the author having examined these two nebulæ during his stay in Rodrigues with the Transit of Venus Expedition. He came to the conclusion that, in the case of the nebulæ round η Argûs, the change since Sir J. Herschel's Cape observations was slight, but that in the other it was very marked; and he supported his view by two beautifully executed drawings of these nebulæ, as seen by Sir J. Herschel and himself respectively. Mr. Ellery, from the observations with the great Melbourne reflector, held that great changes had been going on in the first-named nebula, and mentioned further that a bright light seen in the spectrum of the star η Argûs had varied greatly in brightness in the course of a few months. Mr. Huggins remarked that he had noticed a similar change in the spectrum of the variable star γ Cassiopeæ. Mr. Ellery then described the form in which he had applied Huyghens' parabolic conical pendulum to the regulation of chronographs and driving clocks for equatorials, the principle of this construction being that, as the bob is carried further from the axis the suspension spring is unwrapped from a curved cheek on which it rests, which causes the bob to trace out a parabola, and, by virtue of this condition, when the pendulum is made to rotate, its time of rotation will be the same, whatever be the angle of the cone described. Mr. Ellery found in practice that when connected with a chronograph, the time of rotation of this pendulum was unchanged, even though the driving force was more than doubled. Professor Pritchard after this called attention to the advantages of the form of mercury-trough for reflection observations which he had devised twenty years ago. Mr. Marth, however, pointed out that the same construction had been proposed a hundred years ago, and that it had been again introduced some fifty years ago in essentially the same form as that afterwards suggested by Professor Pritchard. Professor Pritchard, in reply, claimed the merit of originality for his method of cleaning the surface of mercury, though no great difficulty has ever been experienced in doing this by the ordinary plan.

Father Perry exhibited to the meeting some photographs on paper of the transit of Venus, which had been sent to him from Manilla; but there seemed to be an opinion that these were merely photographs of drawings, and therefore of no scientific value. Mr. Ranyard called attention to the signs of duplication in the head of Coggia's comet of last year, as evidenced by Mrs. Newall's drawings as well as those of Mr. With and others, connecting with this the separation of Biela's comet into two distinct bodies, and the double comet of Kepler.

Among other papers presented, were some remarks by Professor Holden on the Ring Nebula in Lyra, as seen with the Washington refractor, accompanied by a photograph of his drawing, and a description of a simple form of observing-chair devised by Mr. Wentworth Erck.

ROYAL GEOGRAPHICAL SOCIETY. LONDON, DECEMBER, 1875.

MAJOR-GENERAL SIR HENRY RAWLINSON in the chair.—Mr. Major, one of the secretaries, read an account of a journey up the Mai-kassa or Baxter River, in the south of New-Guinea, by Mr. Octavius Stone, who, with the Rev. S. Macfarlane, of the Church Missionary Society, had proceeded thither in the Ellangowan, a steamer presented to the society by Miss Baxter, of Dundee. The ascent of the river was northerly at first and then north-easterly, through an exceedingly flat and swampy country, which only began to assume a higher level some distance inland. One channel passed by the expedition, in their progress up the Baxter River, flows in a S. W. direction, and would appear to form a delta. Some few habitations of natives were seen, but only a single native. The furthest point reached was ninety-one miles from the mouth of the river, but Mr. Stone thinks that if the vegetation which there encumbered the stream were to be removed, it would be possible to make one's way in a boat for a score of miles or so further. Traces of wild boars, and of an animal which the travellers took to be a wild ox or buffalo, were found. The dugong, a sort of seal, is common, and a large brown and white bird, with long neck and straight beak, whose wings measured fifteen or sixteen feet across, was seen and shot at. Some specimens of the bird of paradise were also obtained.

Dr. Mullens, Secretary to the Church Missionary Society, then read several passages from letters of the Rev. S. Macfarlane, in which further interesting particulars were given regarding the cruise of the Ellangowan. Dr. Mullens also explained the general plan of operations of the missions located on the south coast of New-Guinea, and the additions to our knowledge of the country which might fairly be anticipated from their efforts.

PHYSICAL SOCIETY. LONDON, DECEMBER, 1875.

PROF. GLADSTONE, F.R.S., President, in the chair.—Mr. Lodge exhibited and described a simple form of chronoscope for measuring short intervals of time, which Prof. Foster has recently devised. The two terminals of the secondary coil are connected, the one with the tuning-fork, and the other with the metallic drum on which the blackened paper is carried. The other connections are as follows: The current passes from one pole of battery to spring of releasing apparatus (which is also connected with one terminal of a separate condenser), thence through the bullet to the fixed portion of the clip and by a wire to the lower table, which is also in electrical connection with the face of the electro-magnet which releases the bullet, in order that the current may be completed immediately the falling body is released. From this table the current passes through an adjusting screw to one terminal of the primary wire of the induction coil which is connected with the other condenser terminal. The other pole of the battery is connected with the primary. The spark in each case is caused by the breaking of the current, which takes place when the bullet is released, and when it strikes the table, the perforations in the black paper of course being made in the trace produced by the tuning-fork. It is hardly neccessary to mention that the releasing electro-magnet is worked by one or two independent cells. The author considers that with a fork making sixty-four complete vibrations in a second, the error, in determining an interval of not more than two or three seconds, should not exceed 1-500th of a second, and that, with a more rapidly vibrating fork, probably much greater accuracy might be obtained. Mr. Lodge made four experiments before the Society, with falls of 2 feet and 1 foot, from which the value of gravity was found to be 32.21.

REGULATOR FOR THE LEYDEN JAR.

Prof. McLeod described and exhibited an arrangement for insuring that the charge given to a Leyden jar shall not exceed any fixed limit. Through a cork in the upper end of a bell-glass passes a brass rod, insulated through its entire length by means of a glass tube through which it passes freely. To the upper end is attached a brass knob, and the lower end is pointed and provided with a screw-thread, so that it can be set at any distance within, or through a hollow brass ball, perforated below, and rigidly fixed to the glass tube. Within the bell-glass is a loose cage of perforated sheet zinc, and a vessel containing strong sulphuric acid. The whole stands on a metallic plate to secure a good earth connection. The action is as follows: If the rod be screwed down so that the point projects through the hollow ball, the upper knob and lower metallic plate being connected with the two poles of a Holtz machine, only short sparks can be obtained, because a large amount of electricity escapes at the point, but if the rod be raised so that the point barely enters the hollow ball at the top, no escape takes place from it, and the machine will give its full length of spark. By varying the position between these two extreme limits, any required length of spark or amount of charge for interposed Leyden jars can be obtained.

[The World.]

THE GERMAN AND AMERICAN NAVAL FORCES COMPARED.

WITHIN the last five years, there has been spent on the American Navy $50,000,000. It has been in existence nearly a century, while Germany as a naval power dates back but twenty-seven years; yet how utterly the latter, in all the essentials of maritime armament, excels the former, people who know little or nothing of the subject may hardly be inclined to believe. Leaving out of the calculation the old sailing-vessels and paddle-steamers, the following is a complete list of the navies of both nations:

IRON-CLADS.

AMERICAN. Monitors.	Tons.	Guns.	GERMAN. Frigates.	Tons.	Guns.
Roanoke	2,260	6	K. Wilhelm	5,939	23
Oregon	2,127	4	Kaiser	4,586	9
Nebraska	2,125	4	Deutschland	4,586	9
Dictator	1,750	2	*Corvettes.*		
Miantonomah	1,225	4	Friedrich Karl	4,003	16
Terror	1,085	4	Kronprinz	3,404	16
Monadnock	1,091	4	Fred. der Grosse	4,118	6
Amphitrite	874	4	Gros. Kurfurst	4,118	6
Ajax	550	2	Preussen	4,118	6
Canonicus	550	2	Hansa	2,372	8
Mahopac	550	2	*Monitor.*		
Manhattan	550	2	Arminius	1,230	4
Saugus	550	2	*Casement ship.*		
Wyandotte	550	2	Prinz Adalbert	779	3
Comanche	496	2			
Catskill	496	2			
Jason	496	2			
Lehigh	496	2			
Montauk	496	2			
Nahant	496	2			
Nantucket	496	2			
Passaic	496	2			
Shawnee	483	2			
Wassuc	483	2			
24 iron-clads	19,771	67	11 iron-clads	39,253	106
Composite vessel.					
Trenton	2,300	11	Not represented.		

WOODEN VESSELS.

Frigates.					
Franklin	3,173	39	Renown	3,318	23
Colorado	3,032	46			
Minnesota	3,000	46			
Wabash	3,000	45			
	12,205	176			

HEAVY CORVETTES (GEDECKTE CORVETTEN).

Tennessee	2,135	23	Elisabeth	1,996	18
Florida	2,135	12	Leipzig	1,996	18
Lancaster	2,120	22	Hertha	1,846	18
Brooklyn	2,000	20	Vineta	1,846	18
Pensacola	2,000	22	Arcona	1,691	18
Hartford	2,000	18	Gazelle	1,691	18
Richmond	2,000	14			
Totals	14,390	131	Totals	11,066	108

(LIGHT CORVETTES (GLATTDECKS CORVETTEN).

Alaska	1,122	12	Freya	1,633	5
Benicia	1,122	12	Ariadne	1,309	6
Omaha	1,122	12	Louise	1,309	6
Plymouth	1,122	12	Augusta	1,550	10
Lackawanna	1,026	10	Victoria	1,550	10
Monongahela	960	11	Medusa	970	14
Canandaigua	933	10	Nymphe	970	14
Shenandoah	929	11			
Swatara	910	8			
Ossipee	828	8			
Juniata	828	8			
Totals	10,924	114	Totals	9,291	65

GUNBOATS.

Kearsarge	695	6	Albatros	601	4
Iroquois	695	6	Nautilus	601	4
Huron	650	6	Basilisk	304	3
Wachusett	695	6	Blitz	304	3
Wyoming	726	6	Comet	303	3
Tuscarora	726	6	Cyclop	304	3
Narragansett	556	5	Delphin	304	3
Alert	450	4	Drache	304	3
Ranger	450	4	Meteor	304	3
Nipsic	410	3	Fuchs	239	2
Nyack	410	3	Habicht	239	2
Alliance	450	4	Hai	239	2
Kansas	410	3	Natter	239	2
Saco	410	3	Salamander	230	2
Shawmut	410	3			
Yantic	410	3			
Totals	8,553	71	Totals	4,515	39

UNARMORED IRON VESSEL.

None.			Falke	1,030	2

GRAND TOTAL.

63 fighting ships, 68,143 tons, 567 guns. 40 fighting ships, 68,473 tons, 343 guns.

Germany thus has a floating tonnage 330 tons greater than that of the United States, counting the Trenton just launched; while in the essential matter of iron-clads, upon which must, of necessity, fall the burden of the fighting in the event of a war, the proportion in favor of Germany is nearly two to one. The comparison becomes much more favorable for the European nation, when it is remembered that nearly all the German iron-clads (the only notable exceptions being the Arminius and Prince Adalbert) are sea-going vessels, while very few, if any, of the monitors could cross the Atlantic. They steam much faster than the American ships, and they are armed with a much more powerful artillery—Krupp's breech-loading steel 72 to 200 pounders. In fact, it is hardly exaggerating to say that one of the nine first-class German vessels could engage with comparative safety and hope of success the whole monitor fleet, selecting, as she could, her own time and range. One shell from the 200-pounder, which has pierced eighteen inches of iron, would settle the account of any individual monitor. Seven of these iron-clads carry armor-plates from nine to fourteen inches in thickness, and are built with all the improvements of the most modern naval architecture. The Renown, a ship whose engines are literally magnificent, was built in England in 1859, and bought by Germany ten years later; the Elisabeth, Thusnelda, Freya, Ariadne, and Louise, are perfectly new and very fast, making from twelve to fourteen and a half knots; the Augusta and Victoria have the same speed, and although the other corvettes are somewhat older, none of them is of earlier date than 1862, and all carry the heaviest breech-loading guns afloat in vessels of their size. Such heavy wooden ships as the Franklin, Minnesota, Colorado, and Wabash, built in 1854, with auxiliary engines, are old-fashioned and slow, and would merely serve as floating targets. The same is true of the heavy corvettes; indeed, it may be said, with more or less emphasis, of all the vessels but the Swatara. If current rumor speaks truly, a German squadron is to visit the United States during the present year. In this case, Americans will have an opportunity to compare their own costly sham of a navy with that of a European power which combines greater efficiency with infinitely less expense, and may learn by the lesson—a lesson which will be all the more emphatic if the comparison is made with the older nations, or those which place a greater dependence on the naval arm.

THE SHAH.

HER Majesty's ship Shah, 26, iron-screw frigate cased with wood, recently had an official trial of her machinery on the measured mile. The engines are horizontal return connecting-rod surface condensers, and the cylinders are 116½ in. in diameter, with a stroke of 4 ft. The ship is propelled by one of Hirsch's screws. The ship was trimmed with 70 tons of iron pigs, disposed on each side of the upper deck to make up for the difference of weights on board, and so bring her down to the same draught as on the former trial—viz., 21 ft. 7 in. forward, and 25 ft. 7 in. aft. The safety-valve was loaded to 32 lb., and the following are the data of the six runs upon the mile with and against the tide, under full power: The pressure of steam in the boilers was 29.5 lb., and the vacuum in the condensers 27 in. forward, and 26.41 aft. The highest mean of revolutions per mile was 67.79, the mean per minute 66.08, and the mean per mile 245.66. The mean pressure of steam in the cylinders was 19.941. The results of the runs were: First mile, 16.744 knots, with 67.50 revolutions; second mile, 16.143 knots, with 67.79 revolutions; third mile, 16.901 knots, with 66.76 revolutions; fourth mile, 15·385 knots, with 65.38 revolutions; fifth mile, 16.981 knots, with 65.09 revolutions; sixth mile, 14.876 knots, with 63.96 revolutions. The mean was thus 16.258 knots an hour, and the mean number of revolutions per minute, 66.08. The mean horse-power developed was 6868.87, which, though exhibiting a great improvement upon the results of the trial in May, was not completely satisfactory. The speed realized, on the other hand, was pre-eminently so. The great difficulty with the engines has been to prevent the metal running out of the bearings when driven at a high rate of speed. The brasses on Thursday were new; and although the precaution was taken to gradually work up the steam by preliminary canters up and down the Solent, the bearings became so injuriously heated that it was deemed necessary to keep a couple of 2½ in. hoses constantly playing upon the heads of the conducting-rods. At the conclusion of the full-power trial, four runs were made under half-boiler power, with the following results: The pressure in the five boilers was 31 lb.; the vacuum in the condensers was 27.81 forward, and 27.12 aft; and the mean pressure in the cylinders 12.212. The highest mean of revolutions per mile was 51.61, the mean per minute 50.47, and the mean per mile 238.25. The indicated horse-power realized was 3212.83, and the speed attained 12.928 knots. Here, again, the speed was regarded as satisfactory. The engines were stopped in 42 sec. under full power, and in 18 sec. under half-boiler power; being stopped, they were started astern in 28 sec. and 7 sec.; and going astern they were started ahead in 14 sec. and 11 sec.

INJURIOUS OCCUPATIONS.

A SPECIAL lecture was recently delivered before the Society of Arts, by Dr. B. W. Richardson, on "Industrial Pathology; or, The Influence of Certain Injurious Occupations on Health and Life." Mr. B. Shaw presided. The lecture began by stating that there were seven active causes producing disease among the working classes—first, noxious inhalations of dust and gases; second, exposure to soluble chemical substances; third, mechanical impact of foreign bodies; fourth, physical injuries from unnatural postures, etc.; fifth, exposure to damp or impure air; sixth, contact with organic parasitic forms; and seventh, excess of muscular work, etc. Turning his attention in the first instance to the injury caused by the inhalation of various sorts of dust, Dr. Richardson said they had all heard of the growth of oidium on the vine, which growth was checked by the blowing of sulphur-dust on the plant. This operation produced a peculiar disease, showing itself in inflammation of the eyeball and other still more serious symptoms. Oidium was a white parasitic fungus, and appeared not only on the vine, but also in the throats of persons suffering from diphtheria. Ammonia often proved injurious upon hatters. The vapor of turpentine produced a specific form of disease, and was more injurious to house-painters than the lead to which their peculiar complaints were commonly attributed. Sulphide of carbon was useful as an anæsthetic agent, but produced disease and insanity when inhaled for any time by men who used it in their occupations. The fumes of nitric acid affected furriers deleteriously. The vapor of chlorine affected bleachers injuriously at first, but on continued use became innocuous. Aniline produced two distinct forms of disease—one neuralgia, the other ulceration, and when the inhalation resulted in death, the flesh was found to be of an analine or mauve color. Nitro-benzine vapor produced headache, and the vapors of metals caused various diseases of the lungs, brain and stomach. The remainder of the lecture went to show that apoplexy, paralysis, insanity, and various other serious diseases, were producible in artisans by contact with injurious substances and vapors, especially that of lead, which affected not only the workingman using it, but also his offspring. Cleanliness and care would greatly mitigate this mischief; but still the startling fact remained that among those workmen who were exposed to the vapors of lead, the deaths were 38 per cent in excess of the ordinary mortality.

INJUNCTIONS TO RAILROAD EMPLOYEES.

MR. D. W. C. ROWLAND, the General Superintendent of the Transportation Department of the Louisville and Nashville Railroad, has issued the following circular to the employees of the road:

"I wish to lay before the employees of this department a sketch of the policy which the company desires carried out, and in which I earnestly request the hearty co-operation of every officer and employee in the department.

"FIRST—*Economy.* The degree of success in every business, but especially of a railroad, depends on the amount of attention paid to economy. I therefore earnestly desire that this element have close attention; that the operative force be always kept at a minimum consistent with efficiency; that no supplies or material be wasted or unnecessarily used, and generally that every thing is done in the most economical manner, and every item of unnecessary expense be cut off. The attention of division-superintendents, agents, and others is especially called to this heading; they are expected to retrench at all times whenever they can see an opportunity to do so.

"SECOND—*Promptness and attention to business* is another element indispensable to success, and I desire that it be displayed by every one in the department; that all correspondence be promptly answered, and full particulars of the matters in point given in the first instance, so as to avoid loss of time and labor in obtaining full information by subsequent correspondence. Reports of accidents and complaints should be rendered without delay, as promptitude in dealing with the parties affected frequently prevents serious trouble and loss. Freight for shipment should be dispatched without delay, and consignees of freight notified promptly as per rules in local freight tariff.

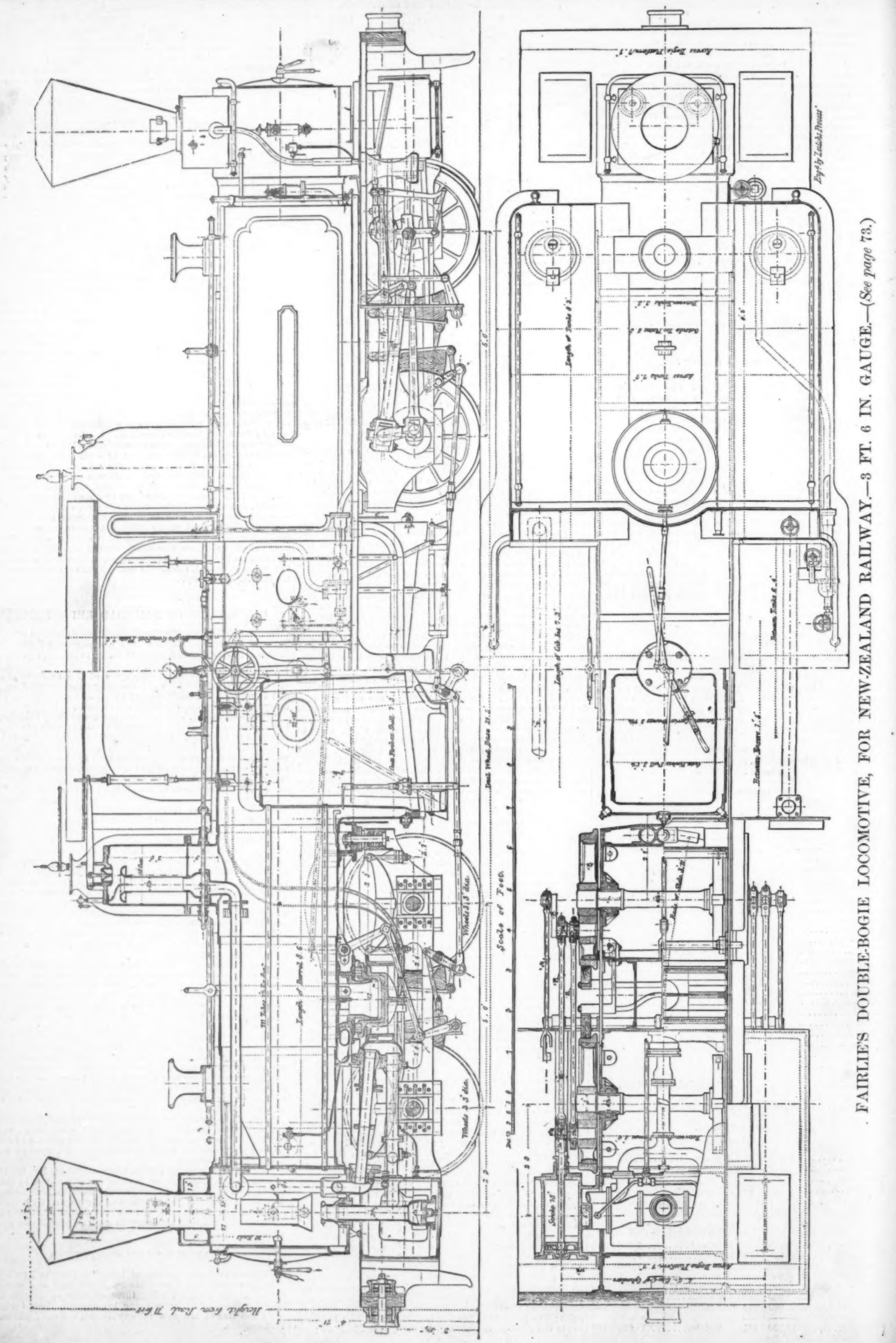
"THIRD—*Courtesy.* We can not expect to secure and retain business unless we are courteous and obliging in all our intercourse with patrons of the road. Employees, therefore, of all grades, are required to give prompt and polite attention to every one who approaches them for information, no matter how humble the person may be, and in a frank and affable manner give the information wanted; or if unable to do so, direct them where to go to get it. Be courteous and obliging to every one, and ready to tender information and assistance even before it is asked, endeavoring to please every body you are thrown in contact with in the way of business or when travelling on the company's trains, at all times avoiding any appearance of irritation, disputes, or controversies with patrons of the road, although there may sometimes seem to be cause to do so.

"It is the desire of the company to have the road, its officers and employees, become popular and gain the confidence and good-will of their patrons, and any thing done adverse to this policy by any one will cause him to be looked upon as unworthy of his position.

"It is earnestly desired that employees of all grades give attention to the points above specified; and I would further add that, in making appointments and promotions, due regard will be paid to the former record of the parties for civility and courtesy, and these will be considered among the foremost qualifications necessary to secure a position or promotion."

A LARGE BRIDGE COMPLETED.

THE new bridge of the Bound Brook Railroad at Yardleyville, the largest on the Delaware River, and one of the largest in the country, being three quarters of a mile in length and semicircular in shape, is complete. This bridge is on the line of the new railway between New-York and Philadelphia.



FAIRLIE'S DOUBLE-BOGIE LOCOMOTIVE, FOR NEW-ZEALAND RAILWAY.—3 FT. 6 IN. GAUGE.—(See page 73.)

FAIRLIE LOCOMOTIVES FOR NEW-ZEALAND.

WE give a perspective view of one of the six double-bogie Fairlie locomotives, constructed by the Avonside Engine Company, Bristol, Eng., for the New-Zealand government Railways, these lines being of 3 ft. 6 in. gauge. We also give on the following page an engraving, showing a longitudinal section and plan of this engine, while on page 74 we give further illustrations showing cross-sections. We are indebted to *Engineering* for the engravings and following particulars. As will be seen from the various views given, these engines are of the eight-wheeled Fairlie type, they being carried on two four-wheeled bogies. The cylinders are 10 in. in diameter with 18 in. stroke, and the diameter of the coupled wheels being 3 ft. 3 in., the tractive force developed is $\frac{10^2 \times 18}{39} = 46.15$ lb. for each bogie, or 92.3 together, for each pound of effective pressure per square inch on the pistons. With a mean effective cylinder pressure of 90 lb. per square inch, the engine would thus develop a tractive force of 8307 lb.

The boiler is of the usual double Fairlie type with two fireboxes, each barrel containing 111 tubes 1¼ in. in diameter outside, by 8 ft. 9¼ in. long between tube plates, and placed 2⅛ in. apart from centre to centre. The external tube surface is thus 765 square feet, and the firebox surface being 88 square feet, the total heating surface is 853 square feet. The grate surface is 15.8 square feet, and the following are the chief proportions of the boiler :

Ratio of firebox to tube surface	1 : 8.9
" grate surface to total heating surface	1 : 54
Ratio of sectional area through tubes to grate surface	1 : 7.7
Ratio of sectional area of chimneys to grate surface	1 : 13.2

It will be seen from these ratios that there is relatively a large proportion of direct firebox heating surface to tube surface, and a large grate area, the engines being intended to work with peat fuel. The dimensions, in fact, clearly show the advantage possessed by the Fairlie system of enabling an ample size of grate to be obtained even on a narrow gauge without any attendant inconvenience. The chimneys are, as will be seen, fitted with a spark-catching arrangement, while the blast-nozzles are kept down close to the bottoms of the smoke-boxes, petticoat pipes being fitted above them.

The two bogies are 16 ft. 1 in. apart from centre to centre, and each has a wheel base of 5 ft. The bogie centres are not placed midway between the axles, but at a distance of 2 ft. 8 in. from the centre of the outer axle of each bogie, so that the total wheel base of the engine is 21 ft. 5 in. The construction of the bogie centres is clearly shown by the longitudinal section and by the left-hand half of the cross-section, Fig. 4, page 74. From these views it will be seen that the carrier frame which connects the two bogies and supports the boiler, tanks, and footplates, is fitted at each end with a hollow cast-steel centre, which enters a corresponding cast-steel socket placed below it as shown. The centre is made slightly spherical, as shown, so as to allow of free movement in all directions. Around the centre there is fixed to the carrier frame a steel plate, and between this and corresponding bearing surfaces, cast in one piece with the socket on the bogie, is interposed a thick india-rubber pad as shown. The part just spoken of as the "centre" does not turn in the socket mentioned, but this socket fits and turns in a cast-iron socket fixed to the bogie frame. The lateral wings, as we term them, of the cast-steel socket also rest lightly upon brass rubbing pieces fixed over the side frames of the bogie as shown in Fig. 4, from which view the whole arrangement will be best understood.

To steady the bogies they are at their inner ends each provided with the spring connection shown in the longitudinal section, and the right-hand half of Fig. 4, this arrangement connecting each bogie frame to a block sliding in a quadrant on the carrier frame. This quadrant is shown at the lower half of the left-hand part of the plan. It will be seen from the right-hand half of Fig. 4 that each bogie at the point of which we are speaking has fixed to it a casting containing two volute springs, which exert an upper pressure against the carrier frame, while between these two volutes is a helical spring which exerts a downward pull upon a bolt which connects the bogie frame to the block sliding in the quadrant already mentioned as being provided on the carrier frame. By this arrangement any tendency of the bogies to either rise or fall at their inner ends is resisted by an elastic pressure, and thus while their motion is controlled, they are not prevented from adjusting themselves pertectly to the inequalities of the road.

The bogie frames are ¾ in. thick and 3 ft. apart, while the bearing springs are arranged inside them and above the axles. The axle bearings are 4½ in. in diameter, 7 in. long, and 2 ft. 8 in. apart from centre to centre. The width over bogie platforms is 7 ft. 1 in., and the width of the engine at the centre over the footplates supported by the carrier frame 9 ft. The tanks and fuel bunkers are arranged as shown in the elevation, plan, and cross-sections, the former carrying 900 gallons of water, and the latter having a capacity of 51 cubic feet.

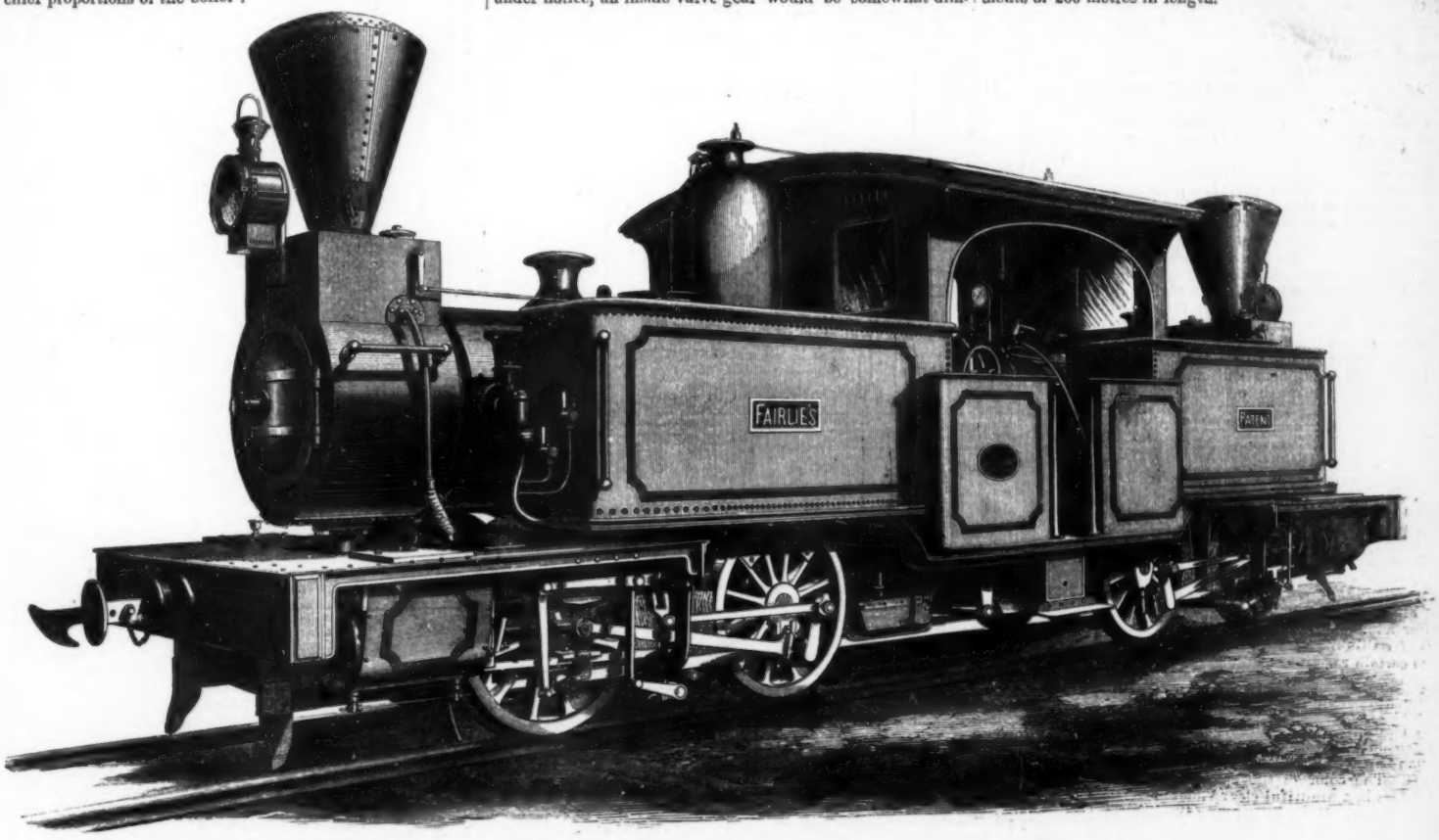
The cylinders are 5 ft. apart from centre to centre, and the slide valves are placed above them in an inclined position as shown on the left-hand side of Fig. 3. The valve gear is of the Walschaert or Heusinger von Waldegg type, as shown in the side elevation. This arrangement of valve gear has been on several occasions described in our columns, and it is excellently adapted for use on engines in which, like that now under notice, an inside valve gear would be somewhat difficult of access. The axles, axle-boxes, and rubbing pieces, tires, crank pins, guide bars, connecting and coupling rods, are of steel, while the pistons are of wrought iron fitted with brass rings. The connecting and coupling rods have each one end made open and fitted with a block secured by a through bolt, this arrangement—or some equivalent one—being necessitated by the fact of the driving crank-pins carrying outside cranks for the valve gear. The brasses of both connecting and coupling rods are adjusted by wedges and screws instead of cutters.

The arrangement of the steam and exhaust pipes is the same as that adopted in all the more recent Fairlie engines, and it has already been described in our pages. The construction of the spherical joints will be readily understood from our engravings, and we need only remark that steam and exhaust pipes thus arranged are found to keep quite tight and to involve no trouble.

The reversing is effected by a hand-wheel and pinion gearing into a curved rack, an arrangement which is admirably suited to the position in which the arrangement has to be worked. The engine is provided with a brake applied to all the wheels, and is also fitted with the Le Chatelier counter-pressure brake arrangement. Sand boxes, fitted with sand valves worked from the footplate, are fixed on the smoke-boxes round the base of the chimney. The weight of the engine is about 23 tons empty, or about 28 tons in working order.

Of the remaining details of the engine it is unnecessary for us to speak, but an inspection of our engravings will show that the whole design has been well worked out. Fairlie engines are now at work in all parts of the world, and on a great variety of gauges, from 1 ft. 11½ in. to 5 ft., and the experience gained in their construction is plainly evident in the later designs. The Fairlie system has lived down its opponents, and its advantages are, we are glad to say, gradually becoming generally recognized. Of the power possessed by the Fairlie system of developing the carrying capacity of narrow-gauge lines we have often spoken, and our statements on this head have been amply corroborated by results, whilst the performances of the Fairlie engines on the Mexican Railway have shown what the system can do on lines almost unworkable by ordinary locomotives.

A GOVERNMENT engineer is at Rock Island preparing models of the arsenal buildings for exhibition at the Centennial. The models will be on a scale of 1 to 300, and will occupy a space 12 x 20 feet.



FAIRLIE'S DOUBLE-BOGIE LOCOMOTIVE, 3 FT. 6 IN. GAUGE.

[The Academy.]

ASTRONOMY.

The Cause of the Aurora.—In 1872 Herr Groneman, of Gröningen (Holland), propounded a new theory of the origin of the aurora, which he afterwards developed at great length in the *Astronomische Nachrichten* for October, 1874; and he has now, in the same journal, extended it so as to account for the geographical distribution of the aurora. According to this hypothesis, there are streams of minute iron particles circulating round the sun, like the well-known meteor streams, and these, when they come near the earth, are attracted by its poles, and form filaments stretching out into space, in the same way as iron-filings sprinkled on paper arrange themselves in lines under the influence of a magnet underneath, each particle attracting the next by virtue of its induced magnetism. Herr Groneman, then, would refer the phenomenon of the aurora to the ignition of this cosmical iron-dust in its passage through the air, the distinction between this and an ordinary meteor shower being that, on account of the filamentous arrangement of the particles in the direction of the dipping needle, streamers are formed which by an effect of perspective appear to radiate from a point in that direction, and therefore nearly overhead. It is necessary to suppose that this meteor-stream is travelling nearly in the same direction as the earth, and Herr Groneman enters into elaborate calculations to show that the velocity of the particles would not be too great to permit the magnetic attraction to form filaments of 200 metres in length.

In his last paper, the author of this theory has attempted to explain the geographical distribution of the aurora, and especially the facts that it is less frequent within the Arctic circle than just outside it, and that it is exceedingly rare in low latitudes. According to Herr Groneman, the direction in which the meteor-stream strikes the earth will explain the first fact, as during the greater part of her course the earth, when she has her pole turned in the direction in which the shower comes, will also have it turned to the sun, so that the aurora would be invisible in the daylight, though its presence ought to be shown by magnetic disturbances. Similar considerations are applied to prove that, at a latitude of 75°, the maximum of frequency will occur at the end of January, observation for one year in Nova Zembla having shown that most of the displays of aurora occur in December, January, and February; but these may have been affected by bad weather in November, whilst in October and March daylight and twilight would interfere to a certain extent.

To account for the rarity of the aurora in low latitudes, the author supposes that the earth makes, as it were, a hole in the meteor-stream (assumed to be an elliptical ring) at each passage through it; and that thus, in course of ages, the parts near the ecliptic will be exhausted of their particles, while those further north or south will only have a small portion removed by the successive circular holes drilled through in the plane of the ecliptic. Herr Groneman does not enter on the question of how far these holes might be filled up under the influence of the mutual perturbations of the particles.

Motions of Stars in the Line of Sight.—In the *Monthly Notices* the results of the spectroscopic observations made at Greenwich Observatory in the last twelve months are given, the most important being those on the displacements of the F line in stellar spectra, from which a motion of approach or recession in the star examined is inferred. Dr. Huggins has the credit of having introduced this new line of research, and his results so far have been verified only by Dr. Vogel at Bothkamp. The Greenwich results, though exhibiting some alarming discordances, on the whole support Dr. Huggins' conclusions, the agreement for all the stars observed in both cases being satisfactory enough. In the course of the observations, it appeared that the measures were largely affected by the particular state of adjustment of the spectroscope at the time, and this led to the adoption of another method of comparison apparently free from suspicion. Thus the earlier results are utterly untrustworthy, a fact which shows the delicate nature of this inquiry; but the recent measures are generally as accordant as can be expected, the chief exception being the bright star Altair, which shows large discordances

arising probably from the difficulty of seeing distinctly the very broad and hazy absorption line in the spectrum of this star. The results for this star are therefore too uncertain to be relied on, but on the other hand a very accordant set has been obtained for Vega, the apparent motion of approach ranging from fourteen to sixty-six miles a second, the mean being some forty miles a second, whilst Dr. Huggins deduced a value of from forty-four to fifty-four miles a second. The observations are so extremely difficult, that it would appear from the results given unsafe to conclude any thing with certainty as to the motion of any other stars examined at Greenwich, though the measures as far as they go support Dr. Huggins, where he has expressed himself with any confidence.

The question is an extremely difficult one, both practically and theoretically, and in his address to the American Association last year, Professor Lovering expressed a very strong opinion that Dr. Huggins' views concerning an alteration in the wave-length of a line (and consequent displacement in the spectrum) resulting from a motion of the star or of the earth, were unsound, basing his view apparently on the *a priori* improbable hypothesis of Fresnel, that the earth passes through the luminiferous ether like a sieve through water, without producing any disturbance in the medium. This supposition was shown by Professor Stokes, thirty years ago, to be entirely gratuitous, the ordinary condition of fluid-motion being sufficient to explain the aberration of the stars, the object for which Fresnel had framed his hypothesis. In this matter Dr. Huggins has also the support of the weighty authority of Professor Clerk-Maxwell; while it is to be remembered that the constitution of the luminiferous ether simply represents the results of observation, and that any mathematical theory as to the behavior of this mysterious ether is only valid for the conditions postulated, so that the theory falls if these are found irreconcilable with observation. Professor Lovering appears to rely chiefly on a negative result obtained by Arago, who found no measurable displacement in the lines of a stellar spectrum caused by the earth's motion, but there can be very little question that his instrumental means were insufficient to decide such a delicate question, and a positive result on the other side would completely outweigh this conclusion. It must be admitted, however, that there is still much obscurity on this point.

[Nature.]

THE NEW METAL, GALLIUM.

IN a communication just made to the French Academy, M. Lecoq de Boisbaudran states that he has succeeded, after considerable labor, in obtaining salts of gallium sufficiently pure to give, in addition to the gallium spectrum, only faint traces of the zinc lines Zn α 144.62 and Zn γ 150.05.

After adding a few facts regarding mixtures of gallium and zinc, he proceeds to examine certain reactions of the pure salts.

1. The electric spectrum of chloride of gallium, a little concentrated, is very brilliant. The line 417 is much brighter than the line 404. The author did not observe any other line attributable to gallium; there certainly are none of notable intensity, under the conditions. The color of the spark in chloride of gallium is a beautiful clear violet.

2. In the gas-flame he got only the line Ga α 417, and very faint and fugitive, even with a salt which gave a brilliant electric spectrum.

3. The chloride and the sulphate of Ga are precipitated by NH_3, but the precipitate is redissolved, in great part, in an excess of NH_3. Taking up with HCl the portion not dissolved by NH_3, and recommencing the operation, all the Ga is promptly obtained in ammoniacal solution.

4. An ammoniacal solution of sulphate or chloride of Ga is precipitated in the cold or hot state by an excess of acetic acid. The liquor must be extremely diluted.

5. The chloride and the sulphate of Ga are not precipitated in the cold state by the acid acetate of ammonia, but the reaction takes place on heating.

6. The sulphate of Ga is soluble in a 60 per cent alcohol solution.

8. A salt was obtained which the author believes to be ammoniaco-gallic alum; though, in default of sufficient quantity, he was unable to analyze it or measure the angles.

9. The alum of Ga is soluble in cold water, but, on heating, the salt is decomposed, and the liquor becomes greatly troubled.

10. This alum is not decomposed in the hot state by water with addition of acetic acid.

11. It crystallizes very easily in cubes and octahedra, presenting exactly the aspect of ordinary alum; its solution, evaporated under the microscope, also presents the characteristic changes of known alums.

12. The crystals do not act on polarized light (between two Nicols giving extinction).

13. A small crystal was kept some time under a layer of water, then transferred to a slightly supersaturated solution of alumino-ammoniacal alum; it immediately increased in it, and caused the crystallization of the liquor.

14. With ammonia in excess, the alum of Ga behaves like the other salts of this metal; a portion of the oxide is precipitated, the other portion remains in solution.

15. The very acid solution of Ga_2Cl_6 is precipitated by the yellow prussiate.

16. The ammoniacal solution of sulphate of Ga is decomposed by the voltaic current. Metallic gallium is deposited on the platinum plate serving as negative electrode. The positive electrode is covered, at the same time, with a whitish pellicle, which is easily detached from the platinum, and is insoluble in a large excess of NH_3. In a first operation 1.6 mgr. of Ga were deposited in 4h. 30m. on a platinum plate of about 185 square millimetres surface. The surface of the positive electrode was about 877 sq. mm. The battery consisted of five bichromate couples (zincs: 17 cm. × 10 cm.) coupled in tension. The author presented to the Academy a specimen weighing 3.4 mgr.; it was deposited in 5h. 40m. on a surface of about 123 to 124 sq. mm. The positive electrode 877 sq. mm.; the current furnished by ten bichromate elements (as above) coupled in tension.

17. Electrolytic gallium forms a very adherent layer; it is hard; it is polished with difficulty by friction with an agate burnisher. A better polish is obtained by strong compression under the burnisher; the metal thus acquires great brightness, and appears whiter than platinum. When the electric current and the relative dimensions of the electrodes are properly regulated, the gallium presents a beautiful dull surface of silvery white, finely granulated, and interspersed with small brilliant points, which the microscope shows to be crystals.

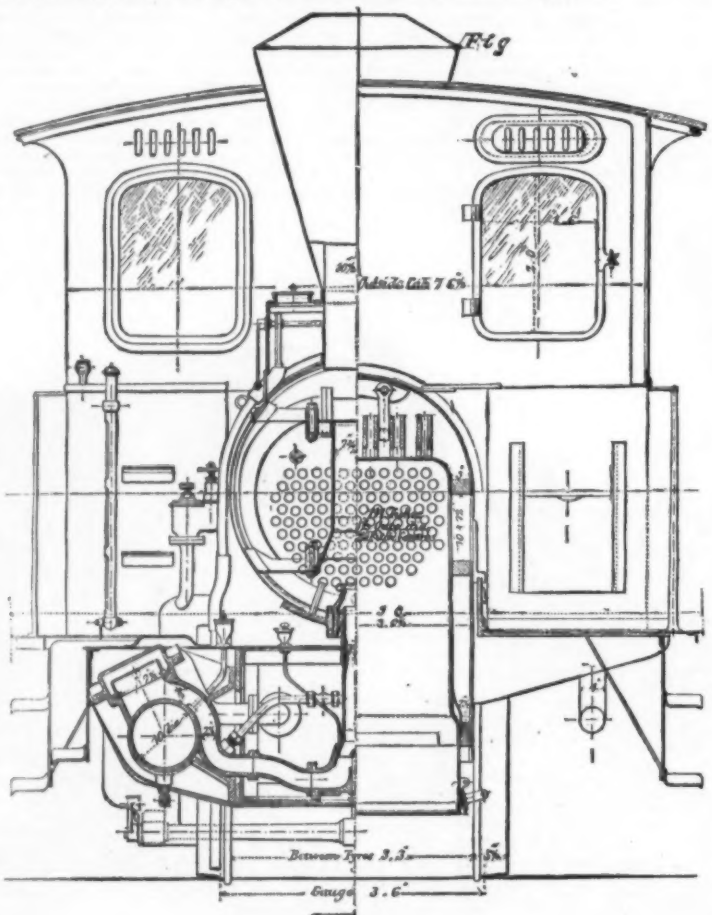
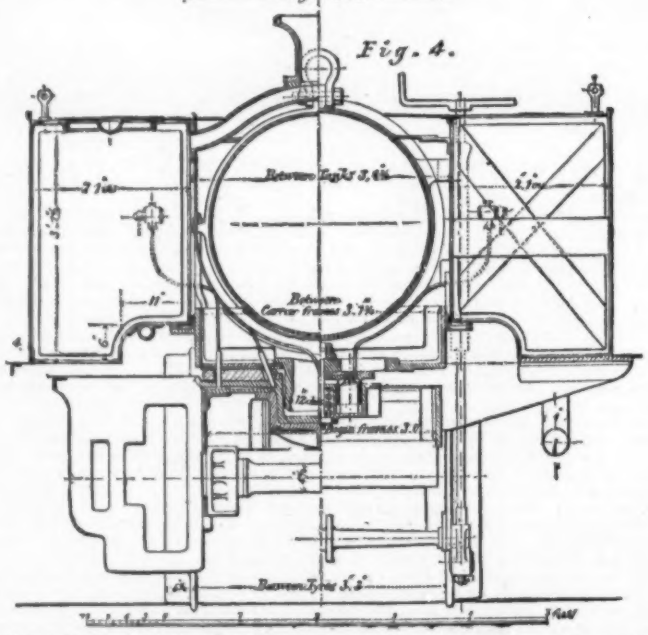


Fig. 4.



FAIRLIE'S DOUBLE-BOGIE LOCOMOTIVE.—3 FT. 6 IN. GAUGE. (*See page 73.*)

18. Gallium, deposited on a platinum plate, is not much oxidized during washing in cold or boiling water, nor on being dried in free air raised to about 200°. It decomposes water acidulated with HCl in the cold state, and more rapidly in the hot state, with a brisk liberation of hydrogen.

The salts of Ga which M. Lecoq de Boisbaudran has used in his researches, have been from the blend of Pierrefitte; he has, however, found the new metal in other ores of zinc, and notably in a transparent blend from Santander. He believes Ga will be met with in all blends. The Ga he extracted from the blends comes really from these minerals, and not from metallic zinc.

The author's last researches have confirmed the rarity of gallium in blend. The extreme sensibility of the spectral reaction led him even to over-estimate the quantities obtained. "I do not think I exaggerate," he remarks, "in saying that in my first observation I possessed at the most $\frac{1}{100}$ of a milligramme of the new substance dissolved in a very small drop of liquid. The spectral analysis of so small a quantity of matter would have been impracticable before the considerable reduction I made in the dimensions of the apparatus for obtaining electric spectra, and without using very small sparks.

"If, as I suppose, there is no error as to the nature of my alum of Ga, the existence of this salt fixes the atomicity of the new element, and attributes to its oxide the same chemical function as that of alumina. The oxide of gallium, then, will be written Ga_2O_3."

The author, in conclusion, refrains, for the present, from discussing the theoretical considerations raised in a recent note by M. Mendeleeff. Questions of the kind have long interested him; but he thinks it very probable that without the particular method followed in the present research, neither M. Mendeleeff's theories nor his own would soon have led to the discovery of gallium.

[Engineering.]

MILITARY RIFLES.

IN all times, and particularly in ours, weapons of warfare, and especially small arms, have been a subject of great and widespread interest. Owing, however, to the numerous and conflicting statements which have so frequently appeared not only in newspapers, but also in books and pamphlets, the public at large, unacquainted with the practical features of the case, have been quite unable to form a sound judgment on the limits to which progress in shooting qualities has attained. Nor is this indecision confined to the public. Many military officers of every grade are equally unable to discriminate between the mass of recent improvements.

This indecision is easy to comprehend, when we think how very complicated the science of the subject is, and how few are acquainted with it even in the army. It is by no means an easy task to be practically familiar, not only with all the questions relating to the construction of arms and their use, but also with the laws of the movement of projectiles. It is comparatively simple to gain a certain theoretical knowledge of the many facts of chemistry, physics, geometry, mechanics, and metallurgy involved; but this theory is useless without that practical knowledge which is only to be obtained by many experiments of a most costly nature, even when undertaken by Government, but utterly beyond the means of a private individual. It is thus only by military committees, aided by inventors, that these problems can be solved. It may be useful to those engaged on the subject, as well as to future inventors, who are, as a class, lacking in special knowledge, to state briefly what has hitherto been achieved, and to make a few speculations on what the future may have in store for us.

The advantage of breech-loading being established since 1866, the attention of competent commissions and inventors has been directed to the question of the proper size of bore to be used. Having long ago recognized the benefit of adopting an elongated projectile of light weight, it then became necessary to determine the following points: The calibre most suitable for a military rifle; the best description of rifling; the relation which should exist between the weight of the bullet and the charge of powder, and between the length and diameter of the projectile; the quality of powder to be used; and, lastly, the total weight of the arm.

It is clear that it was no easy task to answer so many questions. Only now after many trials and enormous expense is it possible to unite all these data in the design for a military small arm.

Many inventors had already proposed weapons of various calibres using different projectiles, which circumstance enabled a decision on the first point to be given in favor of whichever system gave the best results in actual firing. By these experiments, it was possible to determine the limit of the power of small arms. It was shown that calibres between .394 in. and .433 in. harmonized best with the average strength of the soldier and with the resistance of the metal employed. The remaining conditions—namely, how to secure to such a gun a very flat, trajectory, long range, and a convenient system of mechanism, were then examined. At first, bullets with cavities in the rear to act by expansion, universally adopted in 1859, were tried. These bullets were best adapted to muzzle-loading rifles, having a smaller diameter than the bore, in order to leave the necessary space for loading. The bullet was made to take the rifling by being expanded under the action of a quick powder before movement took place. This was found unnecessary for breech-loading guns, in which the bullet may be even larger than the bore, as it is forced into the grooves which impress upon it the desired rotation. Expanding projectiles gave good results at short distances, but not at longer ranges, especially in continued firing. In fact, when bullets were used which, besides being larger than the bore, also acted by expansion, the friction on the sides of the bore became excessive, the gun quickly heated, and the rifling leaded to such an extent that after 30 or 40 shots the firing became wild.

Expanding bullets being generally rejected for breech-loading arms, various elongated projectiles of different shapes made of lead or of an alloy of lead and tin were tried. A slightly conical form gave the best results, but presented certain difficulties in fixing into the metallic cartridge case, and was also found to lead the rifling in the same way as the expanding bullets. To remove these defects, it was proposed to wrap paper round the bullets so as to prevent any contact between the lead and the grooves. These experiments gave good results, especially with bullets made of lead and tin; the leading of the grooves ceased, and the bullet, being harder, yielded less to the action of the gas. Some time afterwards compressed bullets were tried, with results which led to their being adopted by nearly all European States.

This may be said to be the greatest improvement which has yet been made in the practical study of ballistic properties. It is well known that a cast bullet does not give sufficiently satisfactory results in firing; some have holes in them due to imperfect casting, others roughnesses, which necessarily produce differences in weight; they, moreover, always more or less lose their shape by the action of the gas, so that the shooting is irregular and wild.

Experience also proved that the use of wax is necessary to preserve regularity of shooting by lubricating the bore, and removing the fouling which is deposited by the unburnt powder.

The advantages of compressed bullets were no sooner recognized than experiments were set on foot to determine the length and weight of the projectile, and the amount of powder to be used, by which it was shown that the length should be twice and a half the diameter, and the charge one quarter the weight of the bullet. The following table gives the weight of projectiles for bores ranging from .354 in. to .551 in. The charge of powder and the weight of the rifle are also added, by which the impossibility of using an arm of greater bore than .433 in. will be seen.

Bore.	Weight of Bullet.	Length of Bullet.	Weight of Charge.	Weight of Rifle without Bayonet.
in.	grains.	in.	grains.	lb.
.354	216	.885	54	6.6
.394	301	.984	75	7.5
.413	327	1.033	82	8.8
.417	347	1.042	87	9.0
.421	360	1.053	90	9.2
.425	381	1.062	95	9.7
.429	392	1.072	98	10.6
.433	409	1.082	102	11.5
.472	535	1.180	131	14.0
.511	671	1.277	168	16.0
.551	833	1.377	208	19.8

From this table it will be seen that a calibre of .425 in. is already in excess of the proper conditions. The weight of the arm and the charge of powder no longer correspond with the strength of the average soldier, more particularly when the increasing weight of the cartridges, of which he must carry a large quantity, is considered.

On the other hand, we see that the calibre of .433 in., which has been adopted by several powers, is not acceptable, not being suited to the true conditions of firing. Indeed, it will be very difficult to find any army composed of men strong enough to support its weight and the recoil due to its cartridge, if the proper relations were carried out.

A calibre of .413 in. would be the most suitable for adoption, were it not that in proportion as the bore diminishes the bullet decreases in weight; and in this case the resistance of the air would destroy the initial velocity, and consequently lessen the range. Nor could the charge be increased, as then the weight of the rifle would have to be also increased, which would lead to the selection of a larger and more useful bore.

From these considerations, the choice fell between bores of .417 in. and .421 in., and as it was necessary to decide on one or the other, the calibre .421 in. was preferred, as corresponding satisfactorily with all the conditions of the programme. Nevertheless, this calibre may be said not to have altogether the preference, inasmuch as if it is superior in shooting to a calibre of .417 in. it has the inconvenience of greater length and weight of cartridge, which is not altogether balanced by the slight superiority in shooting which it possesses.

But however that may be, these two are the only suitable calibres to give a moderate weight of gun and a good trajectory.

These calibres gave, necessarily, different results, according as they were tried with one or other of the many systems of rifling.

It is natural that the attempt should have been made at first to use the rifling of the old muzzle-loaders, but it was soon seen that the large surface of the rifling no longer suited a compressed projectile introduced at the breech and forcibly made to take the grooves. The bullet used with muzzle-loaders was hollowed out in the rear, as it was necessary that it should be kept firmly pressed against the sides of the bore during its passage along it, to effect which it was essential that the bullet should, under the action of the gas, penetrate deeply into the grooves, and should offer good resistance to the tendency of the sides to collapse, whereby the accuracy of the firing would have been destroyed. While with these weapons, the forcing of the bullet only took place through its expansion into the grooves, in breech-loading arms the contrary is the case, the forcing being effected by the salient portions of the bore, forming the lands or ribs, cutting into the projectile. Experiments, however, have proved that lands or ribs with little surface are best adapted for compressed projectiles, particularly when multiplied and suitably disposed so that the bullet is maintained centred in the axis of the bore round which it rotates.

Numerous trials also showed that the best twist of rifling is one turn in from 20 in. to 24 in., and that the depth of the grooves themselves may vary between .008 in. and .01 in. without danger to the stability of the bullet in the use of various powders. For instance, grooves .008 in. deep are more suited to slow-burning powders like the English fine grain or French B. powders, which only gradually attain their maximum degree of tension (the highest point being about 4¼ in. from the centre of the charge), whilst a depth of .01 in. corresponds better with the action of a quick powder like that in use in Italy, which ignites with such rapidity as to exert an instantaneous and heavy blow on the bullet, which would certainly cause it to strip, if the grooves were not deep enough.

The use of a slow powder is always most important for breech-loading arms of small calibre, because as the gas expands gradually, the metallic cartridge-case and the chamber of the gun are less strained. In addition to this, in passing from rest to motion, the shape of the bullet is not altered (a most important point), as is the case with a quick powder, and thus excessive friction, which is most injurious to the flatness of the trajectory and to the range, is avoided. With regard to the trajectory, too great importance should not be attached to minute differences in flatness, as the range of an arm may suffer in the attempt to secure very great flatness. If we look at the question from the point of view of actual warfare, a rifle, which should have an ordinate of 20 in. in a range of 250 yards, is a better shooting weapon than one having an ordinate of 16 in. It is of little importance whether a man be struck in the forehead or chin; the real question is whether he is struck throughout the whole limit of the 250 yards. The initial velocity of an arm to give an ordinate of 20 in. would be from 1475 ft. to 1640 ft. per second, and its extreme range, 3200 to 3300 yards, whilst that, with an ordinate not greater than 16 in., would have only a total range of 2700 to 2800 yards, without taking into account the great loss of velocity due to a too light projectile, which would make the trajectory very curved at long distances.

There are, however, many who maintain that a difference of 300 or 400 yards in range is not in itself a very great advantage, since, they say, fire is never delivered beyond 1000 to 1200 yards, no attack being ever made beyond that distance.

This opinion is, at least, open to question. It may be said, in fact, that the arm which shoots furthest should always be preferred, if for no other reason than because it strengthens the morale of the soldier. Moreover, it should be remembered that with guns of great range reserves may be harassed, so that it may have to be removed to such a distance as to make it impossible that it should be brought into action at any supreme moment.

In conclusion, it may be said that the limit of the progress of the shooting capabilities of small arms is based upon three unchanging conditions—the strength of the soldier, the weight of the weapon, and the resistance of the air. It has been shown that the weight of an arm of .421 in. bore is the only one which can be admitted. If in this weapon the charge of powder be increased, it will be necessary, as was pointed out for the .413 in. bore, to increase the weight of the arm so as avoid an insupportable recoil and a dangerous expansion of the metal. If, on the other hand, the weight of the projectile is added to or diminished, that of the charge must follow; but supposing that the same charge is retained, it is easy to see that the resistance of the air will act with great force in proportion as the bullet is too heavy or too light.

In the first case, it will be too long, the recoil will be excessive, and the initial velocity will, as a necessary consequence, be affected.

In the second, the velocity will be great on starting, but the resistance of the air will destroy the effect at long ranges.

It may be said, therefore, that no better results will ever be obtained than those given by calibres of .417 in. and .421 in., even admitting that it may be possible to produce a stronger powder and a metal of greater resistance than those now used, unless indeed the art should also be discovered of producing a stronger race of soldiers, which may be doubted.

PNEUMATIC TELEGRAPHY.

PNEUMATIC telegraphy has become quite an institution of the age. Scarcely a capital in Europe has failed to avail itself of its facilities to complete its telegraphic system. When stations lie together, close and thick, it is manifestly advantageous to connect them by mechanical means, so as to save, by the transport of the actual telegrams themselves, the multiplication of wires, apparatus, and clerks; and especially so when this can be done with a rapidity equal to that of telegraphy itself. Messages can not be manipulated or written out at a greater rapidity than forty words per minute, so that if it is possible to transport a telegram itself from one place to another in a minute, not only is speed of transmission obtained, but all sources of error are eliminated. In fact, the average initial delay occupied by messages on the shortest lines is about five minutes, so that tubes which can convey the messages bodily within this limit are economical and beneficial. The essential element of telegraphy is speed of transmission, and it is evident that when currents of air can produce greater dispatch than currents of electricity, pneumatic tubes are preferable to wires. But apart from the question of speed of transmission, tubes are essentially economical in the employment of staff, for their use reduces the number of clerks required to a minimum. But of course there is a limit to their useful employment, and a point is reached when, from telegraphic and economical grounds, wires surpass tubes in efficiency and desirability. The limit of length is about two miles, for at this distance telegrams exceed the five minutes interval allowed for their average transmission. Of course where rapidity is of no consequence this distance can be much exceeded; but, fortunately for the British public, the one criterion which its telegraphists have always endeavored to attain, especially since the transfer of its telegraphs to the State, has been swiftness of transmission, and it is to swiftness more than to any reduction in price that the marvellous increase of business is due. In five years, telegrams in England have increased from six millions to twenty millions.

The first germ of pneumatic telegraphy was sown in the year 1810, when Mr. George Medhurst (who, because he *lived in Denmark street, Soho*, has always been called a Danish engineer) proposed and patented "a new method of conveying letters and goods with great certainty and rapiuity by air." His proposal is so clear and interesting that it deserves extracting:

"If a light and hollow vessel is so formed as to fill the area of a tube, and to move freely through it, carrying papers not exceeding three ounces in weight, it will be driven through the tube with the velocity of 150 feet in a second by the pressure of nine ounces per square inch.

"And therefore a tube of uniform dimensions being laid upon or under ground, from one place to another, without any sudden curvature, will form the means of conveying packets of letters with the velocity of 100 miles per hour, by forcing the air through the tube with a pressure of three ounces per square inch for every ounce weight in motion.

"And if there are two tubes of the same dimensions leading from one place to another, packets of letters may be conveyed each way, at the same time, without a possibility of their clashing against each other; and many packets may be conveyed the same way, in the same tube, which can never approach each other, but will all proceed with an uniform motion and equal rapidity to their destination, where, the the tube entering an air-tight room, the packets will be deposited, and may be delivered or forwarded to the next stage through their proper tubes, commencing in the same room, and their progress can never be impeded by the seasons or the elements."

This proposal did not take practical form until 1854, when Mr. Latimer Clark laid down a 1¼ inch lead pipe between the Electric Telegraph Company's Central Station, Lothbury (LY), and the Stock Exchange. An engine exhausted a receiver at LY, and carriers containing the messages were sucked through from the Stock Exchange. The traffic was only required to flow in one direction. In 1858, the system was extended to Mincing Lane, and about 1860 Mr. Varley introduced the use of compressed air, so that messages were drawn in one direction by a vacuum, and propelled in the other direction by a prenum. Mr. Clark had previously used a vacuum to work in both directions, a receiver at Mincing Lane having been exhausted by the engine at LY, by means of a special pipe laid down in the same trench with the carrier tube.

In 1865 the system was introduced in Paris. Considerable modifications were made in its mode of working. Compressed air was used entirely, and the necessary pressure was obtained by admitting water from the mains into large air reservoirs. This tube served several stations, which were worked immediately, like a line of railway, or a telegraph current, each station having its own store of power to propel or forward the carrier on to the next place. This mode of obtaining power was found wasteful and expensive, and it has been nearly entirely abandoned in favor of steam working at one end of the circuit.

About the same period (1865) a system was introduced in Berlin by Messrs. Siemens, who used two pipes, laid in the same trench, between the Telegraph Station and the Bourse, arranged in a circuit, through which a continuous current of air was always kept flowing in the same direction by a double-acting air-pump, worked by a steam-engine. This last mode of working was tried in London, but it has not proved successful, and it has been abandoned.

It will be seen how closely this system of Siemens' resembles that of Medhurst, and how curiously history works in a circle, for the vision of 1810 has become the stern fact of 1875. In all the places named the pneumatic telegraph has received considerable extension, and it has also been largely introduced in Vienna, where the Parisian system has been adopted.—*Telegraphic Journal.*

[The Medical Record.]

BELLEVUE HOSPITAL.

CHRONIC BRIGHT'S DISEASE.

THE following is a summary of a plan of treatment recommended:

DIET.

This class of patients should abstain as much as possible from meat. The opinion was expressed that the excessive animal diet accounts for the great prevalence of the disease in this country. Milk should be substituted for meat, and should be associated with lime. Butter may be used; eggs if they agree, and fresh fish in the morning. Fried fats should be carefully excluded, but cream may be taken without stint. Vegetables and fruits are *always* good, but those should be selected which contain the least amount of woody fibre. Rice and potatoes, therefore, may be used, but asparagus, turnips, cabbage, and notably beans, which contain woody fibre in large quantities, should be assiduously avoided. Onions may be eaten with impunity, and are rather beneficial.

FOR THE ANÆMIA.

Iron should be administered from first to last, and by preference, the tincture of the chloride. This preparation is assimilated with difficulty, hence should not be given alone, but combined with nux vomica, and to this spirits of nitre may be added to assist the determination towards the kidneys. For example, ten drops of the tincture of the chloride of iron, ten drops of tinct. nux vomica, and one drachm of sweet spirits of nitre may be given three times a day.

Cod-liver oil increases the red corpuscles of the blood, because it is digested by the liver, and the product enters into them as an ingredient. The irritability of the stomach may make it troublesome to take, but it should be relied upon as much as in the treatment of phthisis.

TO COMBAT THE DISEASE ITSELF.

We have one agent which may be regarded as a specific against increase of connective tissue in the body, wherever the interstitial inflammation may occur, and that is the bichloride of mercury. It should be given in small doses, one twentieth of a grain is the usual size, and should be combined with a diuretic to make it act upon the kidney. For example, one twentieth of a grain of the bichloride, one grain of digitalis, and one grain of quinine may be given three times a day, with the result of producing a specific action upon the kidneys, and will *raise* the specific gravity of the urine.

ATTENTION TO THE CONDITION OF THE SKIN

will materially assist the embarrassed kidneys, and to do this we may have recourse to two things. If excessive œdema is present, the pressure produced shuts off the circulation to a great extent and prevents removal of the fluid by diaphoresis. It is much better then to make punctures in the distended skin of the legs, and let the water drain away at once. No apprehension need be had with reference to this trifling operation, if the limb, when the punctures have been made, is wrapped with cloths wet in a solution of carbolic acid in water, to which has been added essence or oil of cinnamon. The latter is to correct the smell of the carbolic, and is also equally antiseptic.

The second thing is, to rub the patient all over once a day with sweet oil. If extra diaphoresis is desirable, it can be best obtained by placing a blanket in an empty bucket, pouring hot water upon it, for in this way much less water is required, and then wringing it out and quickly applying it around the body and covering it with a dry blanket. The skin should be well oiled before the blanket is applied.

Such was a brief outline of the general treatment for this class of cases, and may be suggestive in certain particulars.

[Santa Rosa (Cal.) Democrat.]

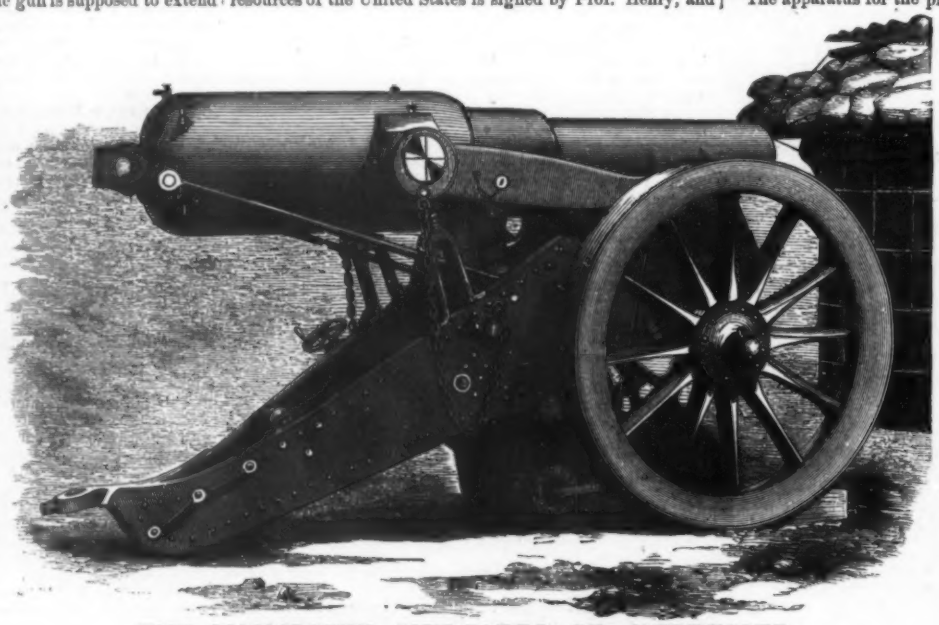
FISHING WITH POWDER.

WE are informed that the infamous practice of killing fish with giant powder is carried to an extent which will soon utterly exterminate all kinds of fish in the streams of Sonoma county. Large and small fish are ruthlessly killed by this barbarous practice. Just now the salmon trout is on its travels to a spawning-ground, which but few will reach. We are informed by an eye-witness that after a single discharge of giant powder in Russian River he counted twenty-seven large salmon with their bellies upward on the surface of the water, and a great number of larger fish of other varieties, and innumerable smaller ones, which were left to decay along the bank. Austin Creek was once the finest stream in the State for trout. Giant powder has been exploded in its waters until all the fish have been killed. In the Lagoon, giant powder has been used, also in Mark West and in the streams throughout the country. We hope that the present legislature will pass a law making the penalty so stringent for killing fish with giant powder that no one will dare to risk it. The destruction of fish has reached such an extent that it is absolutely necessary, to save any at all, that prompt and decided action be taken by the law-making power.

[The Engineer.]

MONCRIEFF GUN-CARRIAGES.

No doubt the greater number of our readers are tolerably familiar with the principles involved in the construction of what is known emphatically as the Moncrieff gun-carriage; but it will be convenient, nevertheless, to explain here those principles very briefly. Major Moncrieff proposed to utilize the force of recoil in a gun to carry it under cover. Let us suppose that the trunnions of a gun are mounted on bearings on the tires of two large wheels placed side by side, and sufficiently wide apart to allow the gun to take a position between them, with one trunnion resting on each wheel; the wheels rest on rails, and are very heavily loaded at points opposite to the gun. Thus, when the gun is as high as it can be got, the counterweights are next the rails. With matters in this condition, the muzzle of the gun is supposed to extend just over and close to a parapet, which is intended to protect the gunners. If, now, the gun be fired, its recoil will cause the wheels to revolve, and run back on the rails; the gun will recoil and descend, and the counterweights will rise. If the apparatus were left to itself, as soon as the force of the recoil was expended, the counterweights overbalancing the gun would descend, carrying the wheels forward, and raising the gun to its original or firing position. If a brake or catch be provided, however, the gun may be held in the place which it reached after its discharge, and will then be ready for loading, and below the level of the parapet by a height equal, say, to half the diameter of the wheels; thus, if these last were 12 ft. high, the gun might be 6 ft. or so below the parapet, and the theory is that the gunners would then be properly protected. As soon as the gun was loaded, by relieving the brake the counterweights would come into action and raise the gun once more to its place above the parapet; it could then be fired, would recoil backwards and downwards, and so the operation could be repeated indefinitely. Our illustrations refer to a recent improvement in which the hydro-pneumatic system is employed and applied to a 64-lb. gun. It will be seen that it resembles the ordinary wrought-iron travelling siege-carriage, and is thus described by Major Moncrieff:



THE MONCRIEFF GUN-CARRIAGE—DEPRESSED.

The apparatus which converts a common siege-carriage into one which recoils into cover on this system consists of five parts, namely, (1) The cylinder and plunger; (2) the radius-bars which support the gun; (3) the elevating arrangement; (4) the extra sights; (5) the anchoring or pivoting arrangement. The cylinder is hydro-pneumatic; the pneumatic chamber surrounds the hydraulic cylinder, in the upper part of which the air is confined by the heavier non-elastic fluid below it—glycerine and water. The air or elastic fluid acts simply as a spring; the manipulation of the carriage is entirely hydraulic. The hydraulic action is effected by means of the main and the throttle valves, which are both self-acting, and by the by-pass valve, which is acted on at the left trunnion by the hand of the man who runs up the gun to the firing position. These valves are removed from exposure or injury, and the apparatus is designed so as to be compact and self-contained. The plunger has a cross-head which works on the radius-bars which support the gun, the radius-bars pivot under the cap-squares of the carriage; where the trunnions of the gun would be in firing the ordinary way, the trunnions rest in the opposite ends of these bars. The elevating arrangements consist of two arms supporting the gun at the breech-patches, and worked at the other end on a curved rack inside of each cheek of the carriage. The rack is centred from the breech-patch while the gun is in the loading position; the axis of the gun, therefore, remains the same in the loading position whatever elevation or depression it may have when run up. In firing at high angles and with low charges, the preponderance of the gun is met, and the gun is elevated or depressed by means of a chain passing between the muzzle and the front of the carriage. The extra sights consist of a reflecting sight, and a direct sight for high angle fire. The anchor, or fixing, of the carriage will necessarily vary according to the nature of the ground. If the battery, for instance, be on a rock, the pivot-chain would probably be most easily fixed by a dowel and wooden wedges. If, on the other hand, it be on soft ground, by burying two baulks of timber with a chain passed round the centre of each.

We believe that our illustrations and the foregoing description will make the action of this gun quite intelligible. If the gun were not anchored, then the carriage would recoil bodily, and the gun would not descend; but the carriage being held firmly, the gun in recoiling descends owing to the action of the radius-bars, which compel it to move in an arc, and this descent is resisted by the air in the pneumatic cylinder, which, when the gun is released after loading, carries the gun up again to the firing position. Two defects appear to us to be inseparable from the system. In the first place, the hydraulic cylinder requires to be charged with air to a pressure of between 500 lb. and 600 lb. on the square inch; and in the second, it appears to be a matter of the most extreme difficulty to anchor the carriage. An air cylinder or two ready charged to six or seven hundred pounds on the square inch forms part of the equipment, and this is not a nice thing to carry about. The mounting and dismounting of the gun is very tedious and troublesome, and a "gyn," or species of shear-legs, must be provided for each gun. The air-holders are 3 ft. long and 9 in. in diameter, and take up a good deal of space, although not heavy. The carriage at best weighs 18 cwt. more than the ordinary carriage; that actually tested weighed 32 cwt. more.

Trials with this carriage were carried out at various dates by the committee of the War Office. They concluded that the hydro-pneumatic machinery of this carriage is of too complex and delicate a character for the rough work to which it would be subjected, not only in a siege but also in the previous transport; and that generally the carriage and its requisites would prove too cumbrous for use in siege operations. With regard to the second point, the committee consider it quite possible that some method of obtaining recoil into cover, more simple and free from most of the objections to which the hydro-pneumatic system is liable, may be devised, or that some alteration in the construction of batteries may give an equivalent protection.

PISCICULTURE.

THE programme of the collection to illustrate the fishery resources of the United States is signed by Prof. Henry, and Spencer F. Baird, United States Commissioner of Fish and Fisheries.

The objects in view are to secure as complete a collection as possible to illustrate the fisheries of the United States, or, rather, of all the resources of the sea, the lakes, and the rivers, for the coming exhibition.

It is desired to illustrate, in the fullest manner, the resources of the United States derivable from the waters, and it will embrace: *first*, an exhibition of the objects themselves, living, in refrigerators on ice, stuffed, dried, or in alcohol, as also photographic representations, and plaster casts colored from nature; *second*, the products derived from the various species, either in their crude state or modified, together with their application in the arts or in trade; *third*, the apparatus by which these objects are pursued, captured, killed, and utilized; and *fourth*, the means by which the same are multiplied by natural and artificial methods, or maintained in a healthy living state.

(1.) The forms more particularly to be illustrated are: *first*, the seals, whales, porpoises, etc., as furnishing skins, hides, oil, teeth, and bone; *second*, the aquatic reptiles, such as the various turtles, frogs, alligators, etc.; *third*, the fishes in their different varieties; *fourth*, the marine invertebrates, or shell-fish, crabs, lobsters, corals, sponges, etc.; *fifth*, the algæ or sea-weeds, and other marine products not of an animal nature.

(2.) Among the applications of objects may be mentioned: *first*, various preparations of flesh and roes, as dried, salted, smoked, pickled, canned, etc.; *second*, oils, spermaceti, etc.; *third*, gelatine, isinglass, glue, leather, shell, whalebone, teeth, and other parts of the animal, in their crude condition, their stages of manufacture, their final condition, and their simpler and more special employments; *fourth*, the different manures derived from the inhabitants of the waters, and the applications of the sea-weeds and other vegetable or mineral articles.

(3.) The apparatus which may be enumerated as used in pursuing, capturing, and utilizing the various species consists: *first*, of special clothing for the protection of the wearer, such as waterproofs, boots, hats, gloves, etc.; *second*, of the different kinds of canoes, skiffs, birches, boats, and rafts, with their oars, paddles, or poles, and other devices for pursuit and capture, or for transportation of the articles, as smacks, merchantmen, etc.; *third*, of bows and arrows, spears, harpoons, lines, hooks, floats, sinkers, reels, rods, artificial flies and baits, nets of all kinds, traps, pounds, dredges, trawls, rakes, etc.

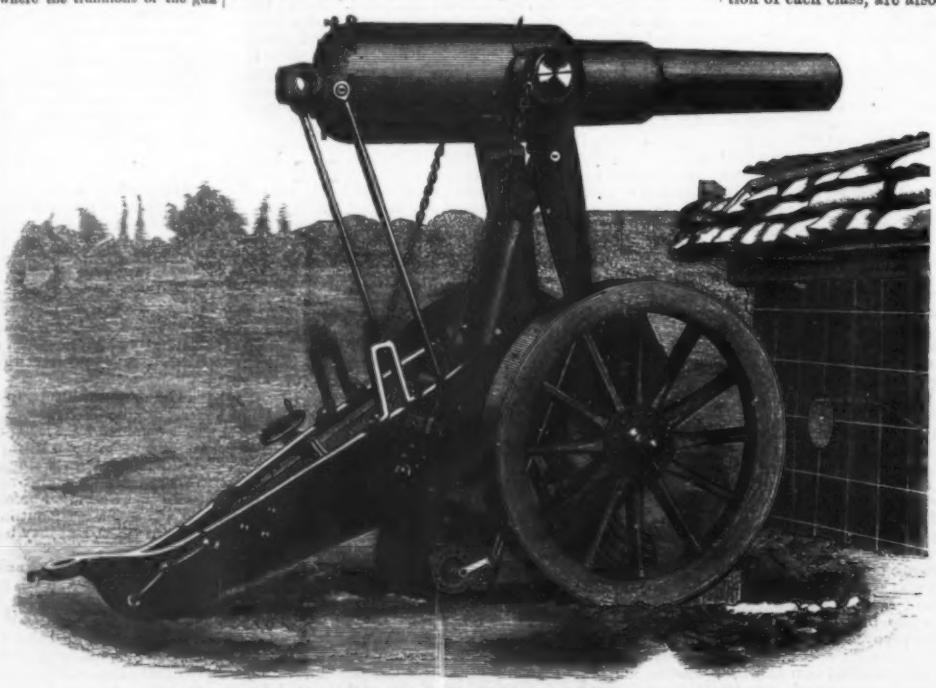
The apparatus for the preparation and utilization of these products will consist of models of smoke-houses, salting establishments, fish-flakes for drying fish, factories for the manufacture of fish or other oils, fertilizers, etc.

(4.) The display under the fourth division will consist: *first*, of plans of piscicultural establishments, models of hatching-houses, model of, or real, hatching-troughs, boxes, trays, screens, and whatever is used in the United States for the artificial hatching of aquatic animals; *second*, illustrations of fish-ways and ladders; *third*, the various devices for transporting living fishes and other aquatic animals and their eggs; *fourth*, those by which such animals are kept living in a healthy condition for the market, for amusement, and for study; *fifth*, ice-houses and refrigerators for preserving them in a fresh state for food; *sixth*, the special apparatus used by the naturalist for collecting living animals, as dredges, trawls, sieves, etc., and also the thermometers, water-bottles, logs, sounding-lines, and other articles for collateral physical research.

As in the case of terrestrial animals and products, the collection will, after the close of the exhibition, be transferred to the Smithsonian Institution, as a permanent feature of that establishment.

The list of the products of the sea and shore of the United States has been drawn up by Mr. W. H. Dall, and is subdivided as follows: 1, Mollusca; 2, Crustacea; 3, Vermes; 4, Radiata; 5, Protozoa; and 6, Marine products not of animal nature.

Exhibitors are invited to send series of all the clams and mussels in spirits, and a full series of the shells at all ages, in the hope of bringing to light more forms of eatable molluscs than are at present known, and much stress is laid on recent particulars respecting locality, etc. In the case of molluscs useful to the arts, exhibitors are invited to send specimens of the creatures themselves, together with the natural and manufactured products derived from them. In all cases the animals injurious to man form subdivisions; the tackle, apparatus, plant, etc., used in the capture or collection of each class, are also included.



THE MONCRIEFF GUN-CARRIAGE—ELEVATED.

[Academy.]

PUTREFACTION OF EGGS.

DR. U. GAYON has been following up the investigations of Pasteur, Donné, and others, to determine the nature of the phenomena of putrefaction of eggs, the results of which he gives in the *Annales des Sciences Naturelles*, vol. i. of the sixth series. Donné contends that eggs would keep good if not shaken, but if shaken they would always turn bad in less than a month. He also asserts that, no matter how rotten an egg may be, no trace of any organisms will be found in it, either animal or vegetable. With regard to the latter assumption, several investigators declare it to be erroneous, and Dr. Gayon figures several organisms met with in decaying and rotten eggs, among the commoner ones *Bacterium termo*, a *Torula*, and an *Aspergillus*. Accepting the presence of these organisms as proved—and the evidence is very convincing—the question arises, how did they get there? It is generally supposed that the germs enter through the pores of the shell; but Dr. Gayon is of opinion that the germs exist in the egg when it is laid. In examining the oviduct and cloaca of several hens, he found the same organisms, and it appears that they are more abundant in fertilized eggs than in sterile. It was also proved that when an injection containing numerous *Bacteria* was used, they were more numerous in the eggs that followed. The fact that the presence of various foreign bodies in eggs, such as portions of insects, small stones, seeds, etc., has been attested by numerous observers, favors this view. Dr. Gayon found germs of alcoholic yeast in the egg of a hen fed upon the refuse from a brewery. Further, Dr. Gayon affirms the statement that moulds are not the cause of putrefaction in eggs. A long series of experiments demonstrated that the act of moving or shaking an egg has little or nothing to do with causing its decay. It seems far more probable that it depends to a great extent upon the nature of the food taken by the hen.

[Astronomy.]

THE DISLOCATION OF THE HEAVENS.

IT may somewhat startle those whose favorite synonym for immutability is the heavens to learn that stability is no longer, in fact never has been, a characteristic of the celestial vault; that the very word firmament is a wretched misnomer, for nothing is firm; that the fixed stars are resolved into gigantic worlds which career through space at velocities of which we can form no conception, and that the constellations themselves are perpetually, though with slowness, changing their forms. Such, nevertheless, is the truth which astronomy proves to us, and by tracing the history of a constellation with which every one is familiar, the Dipper, or Great Bear, we can bring home the facts to our own imagination.

A diagram of the constellation is given in Fig. 1, as it now appears in the northern heavens, and on the stars composing it are marked the Greek letters by which they are known to astronomers. All are of the second magnitude, excepting δ,

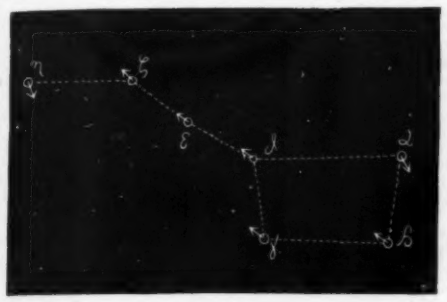


FIG. 1.

which is of the third. After comparing several measures taken at different observations, the result obtained for the proper motion of each star during a century may be summed up by the following table:

Right Ascension.	Polar Distance
α—1"3	+9"
β+1.5	—3
γ+1.6	—2
δ+1.9	—6
ϵ+1.7	—6
ζ+2.0	—4
η—3.3	+3

In Fig. 1 we have also indicated by arrows the direction in which each one of these stars move according to the mean of the measures taken. It will be seen that of the seven, α and η move in one direction, while the other five travel an opposite course. Furthermore, the velocity is not the same in all—η, for example, moving rapidly, while ϵ is quite slow. Through these proper motions the relative distances of the stars continually change. But as this alteration is but a few seconds per century, a great many centuries are required to elapse before any result is visible to the naked eye. Hence, probably, no nation on earth will live long enough to witness any change for the present position of the stars, and, in fact, the time occupied in these changes is entirely too vast to be measured by the minute unit of a year. A better standard is the slow revolution of the globe, causing the precession of the equinoxes, and which occupies a period of twenty-five thousand years. Such a unit is well suited for geological and astronomical measurements of time. Now, in two of these periods—an extremely short time in the history of the stars, for our little earth itself is millions of years old—in two periods or fifty thousand years, noticeable changes in the constellations may occur. Fifty thousand years hence, says M. Camille Flammarion, from whose essay in *La Nature* we take the annexed engravings and translate the facts, the Dipper will appear as represented in Fig. 2; or, rather, the Dipper will have disappeared, and instead the stars will have distributed themselves along a broken line, α having descended toward β, and η having risen above ζ. If we carry the calculation to another fifty thousand years hence, α will have placed itself on a line with γ, and β and η will have travelled below ϵ, so that another Dipper will have appeared upside down, with the bowl in the opposite direction to that which it now is.

FIG. 2.

It is as easy to calculate back as ahead, and therefore we can picture how our constellation looked to the intelligent inhabitants of Mars, Jupiter, and Saturn, if any there were, fifty thousand years ago. The seven stars then formed a cross (Fig. 3) more regular than the Southern Cross now appears.

As the Great Bear, or Dipper, is the most popularly known of all the constellations, so Orion is the most brilliant and beautiful in the entire heavens. Fig. 4 represents Orion as it now appears, showing the respective distances of Sirius, Aldebaran, and Procyon. Sirius, Regel, Procyon, Betelgueuse, and Aldébaran are all of the first magnitude, μ and χ are of the second, as are also the Three Kings, δ, ϵ, and ξ. τ and λ are of the fourth size. Through their proper motions, the four angles marked by Regel, Betelgueuse, γ and χ become altered in different directions. Betelgueuse is least displaced. The star α in the head of the giant, as he is represented on the charts of the heavens, travels toward γ while the latter leaves its place, and the angle at the summit λ, now so characteristic, will disappear. δ and ϵ will approach so near each other as to look like a double star, and afterwards will separate. Procyon, now so far from Orion, will come so near that the astronomers of 50,000 or 80,000 A.D. will consider him a part of the constellation. He will form the southeast angle, and, united by an imaginary line with Betelgueuse and Regel, will represent more closely the right leg of the giant than does now the star γ. Sirius will travel to the foot of the constellation and lengthen the giant's figure; and so, after 50,000 years, the constellation will appear as in Fig. 5.

Orion and the Dipper are but two characteristic examples, and the same calculations may be applied to any of the constellations, as the proper motions of all visible stars are accurately known. Some stars seem to be actuated by a common motion, and groups thus travelling together are found in the Dipper, Gemini, Cancer, Taurus, Leo, and the Pleiades. Curiously enough, all of these motions are in the same direction as is the proper motion of the sun.

ART WORKS IN BRONZE.

By FREDERIC VORS.

MR. FREDERIC VORS, who has charge of the bronze department at Tiffany's, lately lectured on the manufacture and uses of bronze at the Cooper Institute. After quoting M. Thiers' expression that "luxury indicates civilization," he said that patterns for bronze casts were made in wax, plaster, or wood. Some artists used one medium and some another. For common work, such as chandeliers, the pattern was usually made in wood. It mattered little, however, what was used provided it would afford angles and a sharp, clear, smooth surface. Formerly, in copying large pieces of statuary, the artist worked entirely by eye, and the result was that his copy was never perfect. It always had some of the artist's individuality in it. In 1836 Achille Collas, a Frenchman, adapted the pantagraph to obtaining reduced copies of the antique statues. Mr. Vors then explained by means of diagrams how the pantagraph worked. Bronzes, he said, can only be cast in sand. In no other medium will the moulds "take," as the workmen say. The best sand is the yellow magnesium which is obtained from pits near Paris. The pattern made by the artist is laid on a bed of this sand, which is mixed with lamp-black and beaten down hard. Pieces of this sand and lamp-black are then laid on the pattern, so that they can be "drawn" according to the technical term, and the mould is built up over the pattern like so much brick-work. The bronze cast must be hollow. The finest bronzes are the thinnest. The popular idea is just the contrary of this, most people supposing that the heavier a bronze cast the more valuable it is. The Japanese and Chinese model in clay.

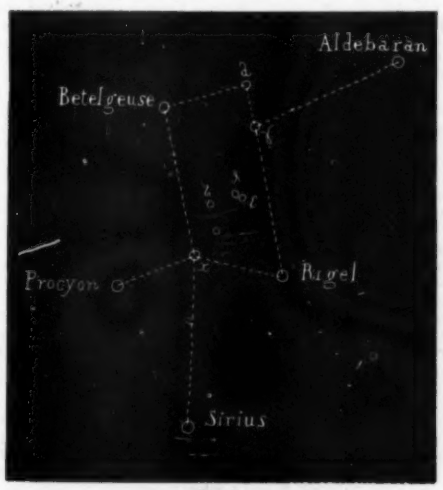


FIG. 5.

This is waxed, then the outside mould is put on, and the heated metal on being poured in of course melts the wax and takes its place. This method was found to answer very well for certain work, but in other kinds it would not do at all. Mr. Vors then read Benvenuto Cellini's description as given to the Duke de Medici, of the manner in which he made his cast of the grand statue of Perseus. This was accomplished by the wax method. It was generally supposed, Mr. Vors said, that the very finest bronze contains silver and gold, one or both, but this error arose from a statement made by Cellini, and which had been misunderstood. The best bronze was composed of 75 parts of copper, 12½ of zinc, and 12½ of tin. Ancient bronze was composed of copper and tin alone, zinc being then unknown. Imitation bronze, sometimes called French bronze, was simply pewter. It was run into iron moulds. The lecturer here exhibited the moulds, tongs, crucibles, and presses used in making bronze casts. The remaining portion of the lecture was devoted to explaining the methods of finishing, coloring, and enamelling. Finishing was accomplished either by the scraper, which gave a perfectly smooth surface, such as the bronzes made by Bari exhibit, or by stipple work, which imitated the texture of the skin. There was also a method of finishing called cross-etching. This was done with a riffler, or file. This is considered the highest style of finish. Bronze is originally of a light yellow color, but by the use of chemical agents almost any color or tint can be obtained. Commonly sulphuret of ammonia is used. The bronze is heated and lamp-black is then rubbed in. The color is actually absorbed into the pores of the metal, so that the bronze can be exposed to the weather without its changing color. Some artists gild the high lights of their bronze bas-reliefs. This is very effective. The gilding is burned in. To make green bronze (verd antique) the surface is covered with verdigris. Olive-green bronze is only a modification of this. Smoke-colored, or Florentine bronze, is obtained by covering the surface of the metal with heated shellac and hanging the article over a fire of straw or shop-refuse. Mr. Vors then spoke of the various methods of enamelling. The Chinese and Japanese were the first to use this art. The famous Cloissonnée enamel is composed of powdered colored glass vitrified. Small ridges of metal are left, or small spaces are punched out of the metal, and the powdered glass is placed in them. The surface is then polished so that it has no appearance of glass, and few persons will believe that the work is accomplished in this manner. The Limoges enamel is only varnish and paint. Cloissonnée enamel is now made in France quite equal in appearance to the Japanese and Chinese, but it is very costly. A small plate is worth $120.

PHENOMENA OF INDUCTION.

By Professor EDWIN J. HOUSTON.

THE publicity given by notices in several newspapers within the past few weeks, of an alleged discovery of a new force by Mr. T. A. Edison, of Newark, N. J., which has been styled by him "Etheric Force," and the manifest general interest in these notices, lead me to present the following communication for the pages of the journal. In the *Journal of the Franklin Institute* for June, 1871, will be found a published description of some experiments which I made shortly prior to the date of publication, and which bear, both in method and results, a partial resemblance to those by Mr. Edison.

The experiments alluded to were made with a Ruhmkorff induction coil, capable of throwing the induced spark six inches in free air. I found that by connecting one of the poles of the secondary coil with a gas-pipe by means of a good conducting wire, and the other pole by similar means, either with a large insulated conductor or with a semi-insulated conductor, as, for example, by allowing the wire to rest on a

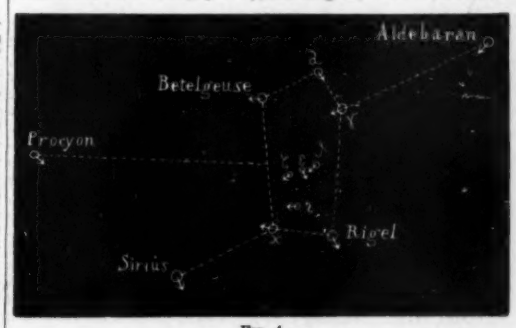


FIG. 4.

dry lecture-table, that the volume or quantity of the spark was greatly increased, and at the same time the characteristic whitening of the condensed spark produced. These results I attributed entirely to a condensation of the spark by connection with extended surfaces, similar to the condensation produced by the introduction of a Leyden battery into the circuit.

During the progress of the experiments the following facts were noted, which bear upon the observations of Mr. Edison. While the interrupter of the coil was in operation, making and breaking contact with the battery, sparks could be drawn from any metallic objects in the neighborhood of the coil, and, indeed, in adjoining rooms. For example, by holding a small metallic object in the hands, sparks were drawn, in an adjoining room, from a large pneumatic trough, in connection by soldered joints with the water-pipes of the building. Similar sparks were drawn from a half-horse power engine, also in metallic connection with the water-pipes, and from the steam-boiler in the chemical laboratory on the floor below. A person standing on the floor could draw sparks from any of the gas-pipes in the adjoining rooms by holding a knife-blade to the pipes or burners. These results I of course attributed to the action of the induced electricity from the coil, and published a note of them merely as a new experiment with the induction coil. On the first hearing of the alleged discovery of the "Etheric Force" by Mr. Edison, I was led to think it probable that the phenomena observed by him were similar to those noticed by me in 1871, but from the descriptions published in the newspapers, was unwilling to make a public note of my belief. In the New-York *Tribune*, of December 9th, however, Dr. Beard, of New-York, has published a fuller account of the manner in which the experiments were conducted, and as far as I can gather they are of a similar nature to mine, and I feel warranted in believing that they can all find a satisfactory explanation by the presence of *induced electrical currents*, without the intervention of any new force whatever.

Immediately on reading the first published account of Mr. Edison's experiments, I repeated my original experiments in connection with my friend, Professor Elihu Thomson, of Philadelphia.

I append a brief description of our experiments. The induction coil already mentioned was worked by means of an electro-poin battery of ten cells coupled for an intensity of ten. The elements of each cell consist of a single plate of zinc placed between two plates of carbon. The available sur-

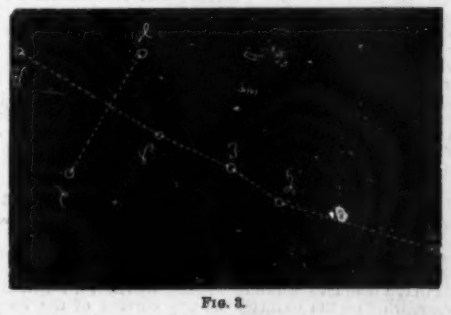


FIG. 3.

face in each cell is about three by six inches. One pole of the battery was placed in metallic connection with a gas-pipe, and the other in similar connection with a large insulated conductor. On working the interrupting break-piece, a torrent of characteristic white sparks of condensed electricity passed between the platinum points of the coil. Under these circumstances, that is, while the discharges were occurring between the points, sparks could be drawn from all metallic objects in the same room with the coil, or in adjoining rooms. The sparks were especially noticeable when metallic objects were approached to the gas or water pipes of the building, or to metallic surfaces in connection therewith, as in the case of the pneumatic trough, steam-engines, and boilers before mentioned. As already implied, actual contact between the gas or water pipes and one of the wires leading from the coil was unnecessary, as distinct sparks were afforded by a stove in the same room, and from another in an adjoining room.

In order to test the suspected similarity between these sparks and those described by Mr. Edison, we submitted them to the tests proposed by him. We made a number of experiments and obtained the following general results, namely:

1st. The gold leaves of a delicate electroscope did not diverge on being brought into contact with metallic objects

yielding the sparks, although in every case the sparks could be seen at the point of contact.

2d. The needle of a delicate astatic galvanometer was not sensibly deflected by the sparks, on an apparent current being caused to traverse the coils of the instrument.

3d. A small shred of cotton wool was not sensibly attracted or repelled by objects from which the spark might be obtained.

4th. The so-called retro-action of the spark was distinctly observed. On looping a wire back on itself, a decided spark was seen at the point of contact made by the end of the wire with any portion of the wire itself.

All the above results are in strict accordance with the known laws of electricity, as will appear hereafter.

To still further compare these results with those obtained by Mr. Edison, we dispensed with the use of the induction coil, and employed an apparatus similar to that described by him, namely, an electro-magnet in connection with the battery already mentioned, the current of which was rendered intermittent by means of an ordinary interrupter. With this arrangement, a wire in contact with the core of the magnet yielded sparks having all the properties described by Mr. Edison.

From a careful reading of the published accounts of Mr. Edison and Dr. Beard, it appears that the alleged discovery of a new force is based on their failure to obtain from the sparks, indications of electrical charges or currents; or, in other words, in the apparent absence of electric polarity. All the effects noticed, however, are readily explainable by reference to the presence of an instantaneous outgoing current, immediately followed by an incoming one, with the complete re-establishment of electrical equilibrium. When we bear in mind the enormous velocity of electrical currents of this character, probably some hundred thousand miles per second, we can readily understand that the flow and reversion of the current would take place in an exceedingly small fraction of a second; a space of time insufficient, were the current merely direct, to produce any decided divergence of the leaves of the electroscope or the needle of the galvanometer. *The presence of the inverse current, immediately following the direct current, would absolutely and necessarily prevent the exhibition of electrical polarity as exhibited in the motion of the electroscopes, galvanometers, and of similar instruments.*

It is doubtless due to the fact that the direct and inverse currents are opposite in their effects, and therefore produce instantaneous electrical equilibrium, that Mr. Edison failed to obtain the characteristic twitching of frogs' legs, or the discoloration of iodized paper; for, although these results would unquestionably follow an electric current in one direction, their presence would be masked by the opposite effects produced by the instantaneously following inverse current.

The possibility of the existence of the direct and inverse currents, as above described, may be questioned; but when we bear in mind that the sparks can only be obtained by the interruption of the battery current, and that it is necessary to pass the battery current through a long coil of wire, conditions in every way favorable to the production of instantaneous induced or extra currents, the direct and the inverse currents follow as a matter of necessity; for the induced or extra currents in the coil of wire necessarily produce, in the core of the magnet and the metallic wire in connection therewith, an electrical current in one direction, instantaneously followed, on the cessation of the induced or extra current, by a current in the opposite direction for the re-establishment of the electric equilibrium in the cores of the magnet.

It is a fact well known to all versed in electrical science, that the induced current produced at the moment of making contact with the interrupter flows in the opposite direction to that produced on breaking the contact. This fact would in itself, exclusive of the above explanation, be sufficient to account for the production of inverse currents in the core of the magnet, when the interruption of the battery current was sufficiently rapid. Dr. Beard admits that the phenomena may be referred to a somewhat similar explanation, but the value he attaches to his supposition may be judged from his subsequent adoption of the term "apolic force" as a preferable term to "etheric force."

It is matter of surprise to us that both Mr. Edison and Dr. Beard endeavored by careful insulation to eliminate in the apparatus employed by them the effects of induced electricity or induction, since it is a recognized fact in electrical science that the more perfect the insulation the more decided the effects of induction; of which, perhaps, no better instance could be found than the care taken to thoroughly insulate the secondary coils in the induction on Ruhmkorff apparatus. In view of the above considerations, we feel warranted in the belief that all the phenomena noticed by Mr. Edison and Dr. Beard are explainable by the presence of inverse electrical currents of considerable quantity, but comparatively small intensity, instantaneously produced at the making or breaking of the battery circuit.

There was noticed, during the progress of our experiments with the induction coil, the following curious phenomenon, which appears to us favorable to the explanations we have adduced. One of the poles of the coil was connected with a gas-pipe, and the other with an insulated conductor of considerable surface in the room containing the Ruhmkorff core. This room is in connection by a telegraph wire with the chemical laboratory on the floor below, and with an earth circuited station, D, in another building, about five hundred feet distant in a direct line. On the interrupter of the coil being worked, a peculiar clicking sound was heard by both of us in the line wire in the chemical laboratory. The operator at D was requested to observe whether any unusual phenomena were noticed at his instrument. He at once telegraphed to us that a distinct "tinkling sound" was heard, which did not vary, whether the ordinary battery current of the line was opened or closed. Since he did not know what to expect, his confirmation of our observation was very satisfactory. The production of the sound is probably referable to a rapid succession of molecular changes produced in the wire by the sudden reversion of its electrical states.

CENTRAL HIGH SCHOOL, PHIL., Dec. 11, 1875.

[NOTE BY THE EDITOR.—It will be observed that these results of Professor Houston were produced by the use of unquestioned electricity, as obtained from the Ruhmkorff coil, and the fact of their exhibiting all the negative properties, as well as the apparent absence of polarity, which Mr. Edison appears to regard as the proof of the existence of the new force, goes to show that the assumption of a new force is simply gratuitous. The experiments made by Prof. Houston had for the source of electricity a Ruhmkorff coil, but the reference in the original article of 1871 to a cylinder or plate machine, demonstrates that the source of electrical force, whether magneto-electric, frictional, or derived from a battery, was, in the opinion of Professor Houston, immaterial. It follows that whatever there may be *remarkable* in the phenomena of so-called etheric force was described by Professor Houston previous to *the discovery* of Mr. Edison.]

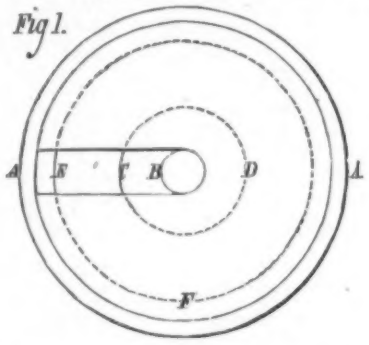
THE WEAR OF METAL SURFACES.

By JOSHUA ROSE.

THE wear of metal surfaces such as cast-iron, wrought-iron, steel, and brass, is governed as much by the conditions under which that wear takes place as it is by the degree of hardness of the metal.

It is a general rule, that motion in one continuous direction causes more wear, under equal conditions, than does a reciprocating motion, and also that the harder the metal the less the wear. To this latter rule there are, however, exceptions in favor of cast-iron, which will wear better when surrounded by steam than will any other metal. Thus, for instance, experience has demonstrated that piston-rings of cast-iron will wear smoother, better, and equally as long as those of steel, and longer than those of either wrought-iron or brass, whether the cylinder in which it works be composed of brass, steel, wrought-iron, or cast-iron—the latter being the more noteworthy, since two surfaces of the same metal do not, as a rule, wear or work well together. So also slide-valves of brass are not found to wear so long or so smoothly as those of cast-iron, let the metal of which the seating is composed be whatever it may; while, on the other hand, a cast-iron slide-valve will wear longer of itself, and cause less wear to its

Fig 1.

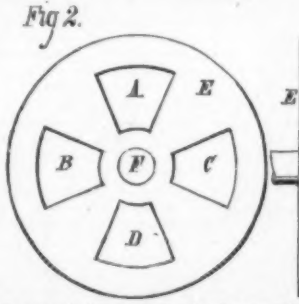


seat, if the latter is of cast-iron, than if of steel, wrought-iron, or brass. The duty in each of these cases is light; the pressure on the cast-iron, in the first instance cited, probably never exceeding a pressure of ten pounds per inch, while, in the latter case, two hundred pounds per square inch of area is probably the extreme limit under which slide-valves work; and what the result under much heavier pressures would be, is entirely problematical.

Cast-iron in bearings or boxes is found to work exceedingly smoothly and well under light duty, provided the lubrication is perfect and the surfaces can be kept practically free from grit and dust. The reason of this is that cast-iron, especially that of American manufacture, forms a hard surface-skin, when rubbed under a light pressure, and so long as the pressure is not sufficient to abrade this hard skin, it will wear bright and very smooth, becoming so hard that a scraper made as hard as fire and water will make it will scarcely cut the skin referred to. Thus, in making cast-iron and a wrought-iron surface, plates or planometers, we may rub two such plates of cast-iron together under moderate pressure for an indefinite length of time, and the tops of the scraper-marks will become bright and smooth, but will not wear off; while if we rub one of cast-iron and one of wrought-iron, or two of wrought-iron, well together, the wrought-iron surfaces will abrade so that the protruding scraper-marks will entirely disappear, while the slight amount of lubrication placed between such surfaces to prevent them from cutting will become, in consequence of the presence of the wrought-iron, thick and of a dark blue color, and will cling to the surfaces, so that after a time it becomes difficult to move the one surface upon the other. If, however, the surfaces are pressed together sufficiently to abrade the hard skin from the cast-iron, a rapid cutting immediately takes place, which is very difficult to remove, the only remedy being to entirely remove the particles of metal due to the abrasion, and lubricate very freely.

Under a light duty, cast-iron, especially when working under steam pressure, will wear longer and better than brass, wrought-iron, or steel, even if the motion be continuously in one direction; thus for revolving side-surfaces, such as discs,

Fig 2.



it retains its superiority over the harder metals, and there is no test so great as is involved under such conditions, for the following reasons:

Suppose in Fig. 1, A A A represents a cylinder, and B a piston revolving in the same; if then we suppose the line C to represent a surface of metal on the piston, and the dotted line D to represent the surface of metal on the cylinder-cover over which the metal represented by C will have to pass in making a revolution, and then suppose the line E to represent another surface of metal on the piston, and the dotted circle F to represent the surface of metal on the cylinder-cover, over which surface the piston surface E will have to pass in making one revolution, we shall find the metal at E will suffer from wear four times as much as will the metal at C.

Thus supposing the circumference C to be eight inches, and that of F to be sixteen inches then the one passes over twice as much metal as does the other in performing a revolution, making the wear on *that* account twice as great at E as it is at C. But this is not all, for the metal at E travelled over its wearing surface, that is to say, the surface it bears against, in making a revolution, at a speed twice as great as did the metal at C over its wearing surface, since E travelled over sixteen inches in the same time that C travelled over eight inches of surface; this increase further doubles the wear at E, making its wear fourfold that at C, and giving us the rule that the wear of a revolving disc increases (as does its area) in the ratio of the square of its diameter. The result of this inequality of wear was demonstrated in the early days of locomotive-engineering, at which time the throttle-valves were in nearly all engines revolving discs, such as shown in Fig. 2—A, B, C, and D representing the openings in the circular valve E, which revolved upon its centre-piece F.

The result of the wear on such valves was found to be very unsatisfactory, because the metal at and near the extreme circumference would wear very rapidly away. The pressure of the steam, however, by springing the outer surface of the disc to its seat, would prevent the faces from leaking, but the pressure of the outer diametrical surface to its seat would be diminished in proportion to the resistance of the metal to the spring referred to, and, as a consequence, the surface of the metal at and near the centre of the disc would bear upon its bearing surface not only the pressure due to the steam acting upon its exposed surface, but an amount in excess equal to that to which the outer diameter was relieved in consequence of its resistance to spring.

These conditions would continue until the wear of the larger diameter becoming greater, and the amount of spring required to keep it to its seat increasing in proportion, the resistance of the metal to so much spring partly relieves the pressure of the larger diameter to its seat, and since the pressure due to the force exerted by the steam upon the exposed surface of the disc will remain constant to whatever amount the pressure to its seat, the outer diameter is relieved, that at and near the centre, forcing it to its seat, will be augmented, until at last the excessive pressure will cause it to cut or abrade, which action will continue until the cutting at and about the centre will allow the larger diameter to bed with more force to its seat, by diminishing the amount of its spring, and hence its resistance to the steam-pressure immediately behind it, whereupon its excessive wear would recommence.

If, however, the thickness of the disc were made such as to enable it to resist the steam-pressure without springing, the larger diameter would wear sufficiently away to cause the valve to leak; whereas, if the disc were made sufficiently thin to enable it to spring easily, the outer diameter would wear to almost a feather-edge, while the metal about the centre would nearly maintain its original thickness.

It is this inequality of wear in revolving, or side, or disc surfaces that is the stumbling-block to the success of rotary-engines, nor has there as yet been suggested any method of overcoming or compensating for it. It is difficult, indeed, to perceive in what direction such a remedy can lay, unless it be in making the disc of hardened steel and tempering it, so that being at the outer diameter as hard as fire and water will make it, it is so tempered that it shall be gradually softer as the diameter decreases, until at the centre it is quite soft. Thus the degree of hardness of the metal will be as far as possible in proportion to its liability to wear.

In an experiment made by me, I revolved two cast-iron disc-surfaces, of three inches diameter, under a pressure of steam of 20, 35, and 70 lbs. of steam, alternately, per square inch, the surface being pressed together under a pressure of about 7 lbs. per square inch, and the discs making three thousand revolutions per minute. I found that, in consequence of the light pressure, forcing the faces together, a cast-iron surface showed but very little signs of wear—not sufficient, indeed, after running ten hours a day for ten days, to efface the scraper-marks from the surfaces, which had become polished and glazed, as it were. Several small holes were then drilled in the contacting surfaces, and plugs of Babbitt metal, brass, wrought-iron, and steel, were inserted, the faces being re-scraped all over, and the discs then run as before, the result being that, after two days of running, the cast-iron appeared smooth and bright as before, while the brass, wrought-iron, steel, and Babbitt metal were found to be worn positively below the surface of the cast-iron, several repetitions of the last experiment giving, in each case, a like result.

The reason that the liability to cut is found in practice to be much greater in revolving than in reciprocating surfaces is that, when a revolving surface commences to cut, the particles of metal being cut are forced into and add themselves, in a great measure, to the particles performing the cutting, increasing its size and the strain of contact of the surfaces, causing them to cut deeper and deeper until at least an entire revolution has been made, when the severed particles of metal release themselves, and are for the most part forced into the grooves made by the cutting.

In reciprocating surfaces, when any part commences to cut, the edge of the protruding cutting part is abraded by the return stroke, which fact is clearly demonstrated in either fitting or grinding in the plugs of cocks, in which operation it is found absolutely necessary to revolve the plugs back and forth, to prevent the cutting which inevitably and invariably takes place if the plug is revolved in a continuous direction. Furthermore, when a surface revolves in a continuous direction, any grit that may lodge in a speck, hollow spot, or soft place in the metal, will cut a groove and not easily work its way out, as is demonstrated in polishing work in a lathe; for be the polishing material as fine as it may, it will not polish so smoothly unless kept in rapid motion back and forth. Grain emery used upon a side-face, such as the outer face of a cylinder-cover, will lodge in any small, hollow spots in the metal and cut grooves, unless the polishing stick be moved rapidly back and forth between the centre and the outer diameter. If a revolving surface abrades so much as to seize and come to a standstill, it will be found very difficult to force it forward, while it will be comparatively easy to move it backward, which will not only release the particles of metal already severed from the main body, and permit them to lodge in the grooves due to the cutting, but will also dislodge the projecting particles which are performing the cutting, so that a few reciprocating movements and ample lubrication will, in most cases, stop the cutting and wash out the particles already cut from the surfaces of the metal.

It is held by many that fast-running bearings filled with Babbitt metal will wear better than brass bearings. Such, however, is not the case, if the bearings are properly fitted; the only advantage possessed by Babbitt-metal bearings is that they are more easily fitted; because the Babbitt will run so as to make an even and equal bearing upon the shaft, and it is therefore only necessary to set the shaft true before pouring the metal, to insure an even and true bearing; whereas, after the brasses are fitted and bored, they require fitting to the shaft while in their places, and this being a somewhat tedious operation is often omitted, the consequence being that the journal does not bed fairly on the bearing surface, and thus the whole strain of the bearing is placed upon the reduced surface of the brasses which beds upon the journals, and the increase of journal-pressure per inch, placed upon the brass, induces undue abrasion, and a consequent rough surface tending to produce continuous abrasion and heating. In bearings of this kind, the boxes or bearings should be of hard composition, as, say, a mixture of 12 parts of copper to 1½ of tin, and ½ of zinc, which will turn in the lathe easily, and yet be sufficiently hard to resist abrasion under ordinary duty.

[Nature.]

THE THEORY OF "STREAM LINES" IN RELATION TO THE RESISTANCE OF SHIPS.*

(Continued from page 59.)

A CISTERN (see Fig. 20), in which a definite head of water is maintained, discharges itself through a continuous series of pipes, which in the local changes of diameter exhibit the several characteristic features which have been under consideration.

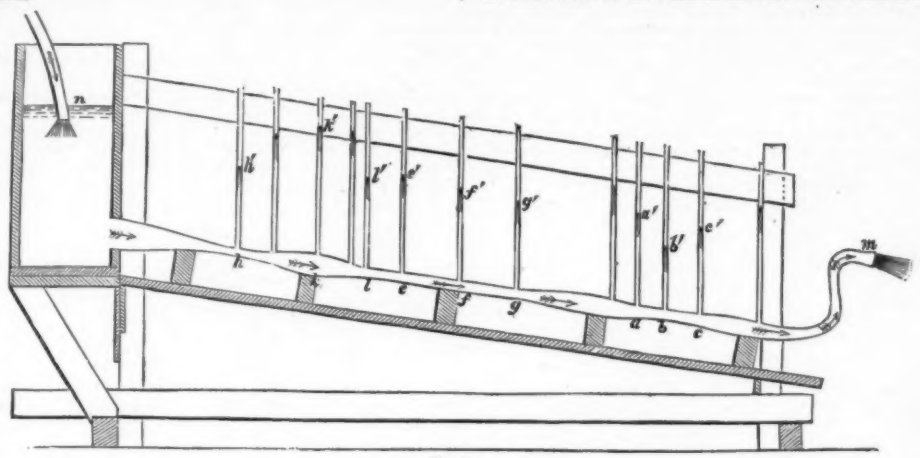


FIG. 20.

From *a* to *b* at the outlet end we have a contraction followed by an enlargement; from *e* to *g* the diameter is uniform; from *h* to *l* we have an enlargement followed by a contraction. At the various critical features are fitted gauge-glasses such as have been described, so that the level at which the water stands in each indicates the pressure in the pipe at the point of attachment.

The series of pipes is laid out on an inclination which represents the mean resistance due to friction, or the "head" lost by friction, between the cistern and the outlet—in other words, the hydraulic mean gradient.

The mean diameter of the contracted part between *a* and *b* has been so determined by well-known hydraulic rules, that when it is compared with the adjoining parallel pipe, the hydraulic gradient shall be the same in each.

You observe that while the levels at which the water stands in the several gauge-glasses corresponds from end to end with the gradient from the head in the cistern to the head at the outlet; when examined in detail, they verify throughout the propositions I have been establishing. Broadly speaking, where the diameter is smallest, the pressure falls most below the mean gradient; at the points where the diameters are equal, the pressures allowing for the gradient are equal, and what is a quantitative verification, the gradient, or loss of head per foot between *a* and *b*, as indicated by the gauge-glass levels *a'* and *b'*, is identical with that indicated by *e' f' g'*, the gauge-glass levels connected with the parallel pipe.

In dealing with pipes of varying sectional area I have hitherto treated only of the modifications caused in the forward motion of the particles of fluid; for I have limited the argument to cases where the alteration in sectional area of the pipe is so gradual that, practically, the only alteration in the motion of the particles is that in their forward velocity; but I have previously shown that tortuosity in a pipe of uniform diameter does not introduce endways pressure, provided the initial and terminal directions are the same; and it is easy to see that an elongated system of such gradually tapered pipes as we have been considering may be also tortuous without introducing endways pressure. Now, tortuosity of flow is but another word for sideways deviation of flow.

This leads us up to the case of more sudden contractions or enlargements in pipes, where the particles next the sides of the pipes have to follow their surfaces and must therefore be moved rapidly sideways in their course.

We will, for simplicity, consider the case of a contraction (see Fig. 21), and one in which the pipe resumes the same diameter beyond the contraction.

FIG. 21.

The particles along the central line pursue a straight course, and are subject only to the changes of pressure necessary to induce the changes of velocity.

To consider the behavior of the other particles, let us assume that we insert a number of perfectly thin partitions (see Fig. 22), which we lay in such a manner that they exactly follow the paths of the particles of fluid at each point, so as not in any way to affect their motion: these partitions are quite imaginary, and merely assist us in looking upon the entire fluid in question as divided into a number of small streams. These streams are generally curvilinear, and vary in sectional area; and at the point beyond the contraction where the pipe resumes its former sectional area, we shall naturally find these minor streams occupying the same sectional area as before, and moving with the same velocity as before.

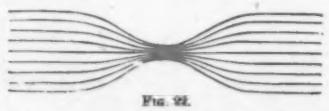


FIG. 22.

Now each of these small streams is exactly represented by a stream of fluid flowing within a pipe, that pipe being curvilinear and gradually varying in sectional area, and its two ends being of the same sectional area and in the same straight line. We have seen that in the case of such a stream, the sum total of all the forces due to its motion has no resultant longitudinally; and this will be equally the case, whether the envelope of the stream be an actual pipe or the mutual pressure of adjacent streams; this envelope will not be removed endways by the flow of the fluid. What is true of each stream is true of all put together; and thus it follows that the whole body of fluid which these separate streams constitute does not exert any endways force; or, in other words, there will be equilibrium of fluid forces throughout the passage of the fluid through a local contraction in a pipe such as we have been considering. The same line of argument evidently holds good in the case of an enlargement, where the pipe beyond the enlargement regains the same diameter as before.

In illustration of the conclusions which have been thus far established, if we had a perfect fluid with which to try the experiment, we might exhibit a very instructive and striking result.

Assume a perfect stream of fluid flowing through a pipe of very large diameter, A B C, with a contraction in it at B, as shown in Fig. 23, and that the equal pressures at A and C on either side of the contraction are indicated by the head of fluid in pressure-gauges A D, C E—the pressure at B, which will be less, being represented by the height B F. Now, the condition of the pipe at A will be just the same if we suppose the

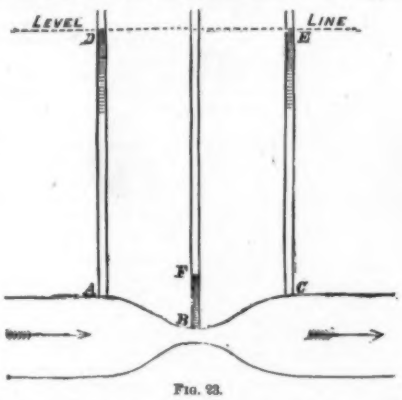


FIG. 23.

pipe supplied from a large cistern G, as shown in Fig. 24; and the appropriate pressure at A will be maintained, if the fluid stands in the cistern G at a height H, equal to the head A D in the pressure-gauge. So, again, the condition of the pipe at C will be the same if the pipe discharges into a cistern, I; and the appropriate pressure at C will be maintained, and can only be maintained, if the water in the cistern stands at a height J, equal to the head C E in the pressure-gauge, which is, in fact, the same level as H in the cistern G; so that if we once establish the motion through the pipe A B C, and maintain the supply of fluid, we shall have the fluid running rapidly, and continuing to run with unabated rapidity, from one cistern into another, though both are at the same head.

If we take such a condition of things that the pressure at B is zero, or, in other words, if the velocity at B is that due to the head A D, then we might cut the pipe at B and separate the two cisterns as shown in Fig. 25, and we should find the fluid issuing at B in a jet, and re-entering the pipe again at K, and rising as before in the cistern I to the same level with a perpetual flow.

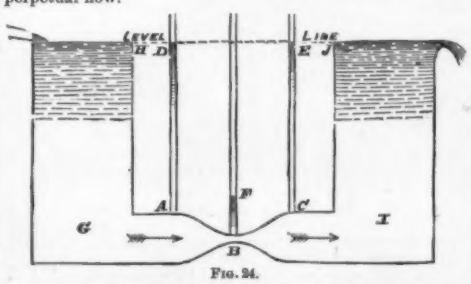


FIG. 24.

The experiment here suggested is, if rightly understood, only a specialized instance of the properties of what in the previous experiment was termed a contraction followed by an enlargement; it is, in fact, as if in that experiment the diameter of the contracted part had been so far reduced that the pressure within it would have sunk apparently to zero, that is to say, in reality to the pressure of the atmosphere; in that case, of course, the pipe which inclosed that portion of the stream would have become simply an inert envelope, and might have been removed without affecting the dynamic properties of the stream. Theoretically indeed with the frictionless fluid the contraction of jet might be carried so far as not merely to obliterate all positive pressure, but to produce a negative pressure equal to that of the atmosphere. For in fact the conditions thus brought into operation would be in effect identical with those which would exist were the experiment performed *in vacuo*, and the head in cistern and at the outlet were both increased by 34 feet; but the theoretical possibility thus indicated is greatly curtailed by friction, and the illustrative experiment I am about to exhibit deals only with the case in which the pressure at the contraction is reduced apparently to zero, or in reality, as I have said, to that of the atmosphere.

In the apparatus as here arranged, consisting of the discharging and the recipient cistern, with the intervening jet-orifice and recipient-orifice, the overflow of the recipient cistern is at 18 inches above the centre of the orifices.

As I continue to fill the discharge-cistern, you observe the jet shoots across the open space between the orifices, and the water-level continues to rise in the recipient cistern; and so long as the head in the former is maintained at a moderate height above that in the latter, the whole of the stream enters the recipient orifice, and there is no waste except the small sprinkling which is occasioned by inexactness of aim, and by the want of exact circularity in the orifices.

When the head in the recipient has reached the overflow, and thus remains at a steady height of 18 inches above the orifices, the complete reception is insured by maintaining a head of 20½ inches in the discharging-cistern, or an excess of head of 2½ inches on the discharge side; and this excess, in effect, represents the energy wasted in friction.

You observe that as I diminish the supply of water and allow the excess of head in the discharger to become reduced, a steadily increasing waste becomes established between the orifices; and it is interesting to trace exactly the manner in which the friction operates to produce this result.

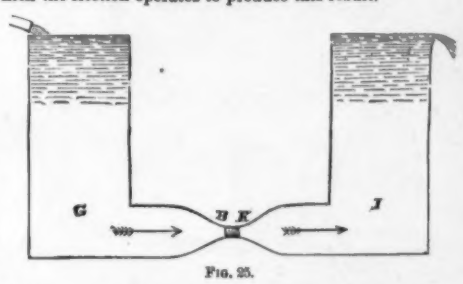


FIG. 25.

If the conoids of discharge and reception are tolerably short as they are here, it is the outer annule or envelopes of the stream which are in the first instance affected, that is to say retarded, by friction, and the escape or waste between the orifices implies that this surface-retardation has reduced the velocity of those envelopes below that due to the head in the recipient; thus an annular counter-current is able to establish itself, and in fact constitutes a counter-discharge from the recipient.

As the quantity of water which actually enters the recipient, or, in other words, the speed of the inflow, is reduced, the friction which belongs to that part of the stream is reduced also, but that which belongs to the issuing jet is unabated, and this circumstance virtually magnifies the waste; it is probable, however, that to the last the velocity of the central zones of the jet remains equal to that due to the head in the discharger, and hence you will observe that unless this is reduced below the level of the overflow, the head in the recipient is fully maintained to that level, though the whole quantity discharged is wasted between the orifices.

When the supply is altogether cut off, both cisterns simultaneously empty themselves, the two jets meeting between the orifices, and becoming spread into a beautiful plane disc or film of water at right angles to the line of discharge; but you will notice that from some inequality in the commencement of the action, and to some extent probably from a quasi-instability in the equilibrium of the double discharge, one of the jets will presently for a moment get the better of the other and drive it back so as almost to arrest its flow, and thus for the moment arrest also the waste of head on that side; but the momentary excess of head thus occasioned almost instantly asserts its superiority, producing a jet of superior force, and thus driving back for a moment the opponent by which it had just before been mastered. Thus a curious oscillation of discharge ensues, which is to a large extent a true dynamic phenomenon somewhat analogous to that which becomes established in an inverted syphon partly filled with water, if for a moment the head is increased in one of the legs; the reaction which in the syphon is furnished by its continuing through the bend, is, in the case before you, furnished by the dynamic reaction of the jets, but the circumstances here involve an instability which does not exists there, so that the small initial disturbance presently magnifies itself into one of considerably greater range.

This curious corollary phenomenon of the alternated retardation of discharge, though not strictly relevant to the main object of the experiment, is nevertheless highly interesting in itself, and tends to enlarge our apprehension of some of the characteristic features of fluid dynamics.

(To be continued.)

LONG-RANGE RIFLE-SHOOTING.

GENERAL SHALER, President of the National Rifle Association, has made a series of experiments at long range, designed to determine the proper charge of powder to be used, of which he reports that up to 1000 yards, the 105-grain ammunition, both with and without lubricant, has shown great merit. While the lighter ammunition produced the best results at 500 yards, it gradually gave way at the longer ranges to the heavier. From this it may be reasoned that the longer the range the more powder should be used, and so far as these experiments show, such reasoning would be sound; but the general opinion is that the increase in the powder-charge which may be made to advantage is very limited. Indeed, until recently, it was thought that the limit was reached at 100 grains. These experiments have, however, satisfied General Shaler that as high as 115 grains, and possibly 120, may be used to advantage at 800, 900, and 1000 yards. It is also thought that these charges of powder will produce improved scores at the longer ranges of 1100 and 1200 yards, which opinion is sustained by the fact that in all these tests the elevations were lowered in proportion to the increase of the powder.

[Advertisement.]

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* Address to the Mechanical Section of the British Association, Bristol, by William Froude, C.E., M.A., F.R.S., President of the Section. Revised and extended by the author.—*Nature*.

[Engineering.]

WILLAN'S THREE-CYLINDER ENGINE.

Constructed by MESSRS. TANGYE, England.

THE perspective view shows its admirably neat and compact design. In this engine each piston forms a valve to one of the other cylinders. The cylinders A′ A″ A‴ are single-acting, and are placed side by side, the pistons—which are made very deep—driving by means of the connecting rods D, three cranks placed at an angle of 120 deg. with each other. The steam inlet is at M, this steam chamber communicating by ports E with each cylinder. Through these ports the steam passes into a groove K formed round each piston, and when a piston—as, for instance, that marked B‴—has made about five-eighths of its downward stroke, the steam passes from this groove K into a port G formed in the side of the

WILLAN'S THREE-CYLINDER ENGINE.

cylinder, and thence is led through a suitable passage to the top of one of the other cylinders. On its way the steam traverses the reversing-valve L, and it is the position of this valve which determines to the top of which cylinder the steam thus admitted by the action of the piston B‴ is led, this also determining the direction of motion of the engine and completely controlling it. The steam admitted to a cylinder by the downward movement of one of the pistons, as above described, is cut off by the subsequent upward movement, while a continuation of this upward movement causes the port G to be uncovered by the piston, the steam being thus allowed to exhaust into the casing H surrounding the crank-shaft. The pressure exerted by the steam being always in one direction, the engine can be run at almost any speed without noise or inconvenience, while the distribution of steam effected is very good. For driving fans, centrifugal pumps, or similar high-speed machinery, this engine is exceedingly well adapted, while it might readily be arranged as a very handy wall engine for driving fast-running shafting.

[The Telegrapher.]

ELECTRO-MECHANICAL DUPLEX TELEGRAPH.

ALMOST every one who has been an attentive reader of the electrical and telegraphic journals for the last three or four years, must by this time have arrived at the conclusion that there is more than one way to make a "duplex." The readers of *The Telegrapher* are herewith presented with a description of another invention of this kind, which differs very materially in principle from any which has thus far been published.

The essential requisite in all methods of duplex telegraphy is to so arrange the relay or receiving instrument at the home station that it shall be prevented in some way from responding to the movements of the sending operator's key, but shall, nevertheless, be affected by the closing and opening of the key at the distant station. In most of the duplex systems hitherto invented, this result has been arrived at in one of the two following ways: First, by providing the relay with a double helix, one part of which is included in the circuit of the main line, the other part being placed in either a branch of the main line or in a local circuit, which is closed at the same instant as the main line, but has the effect of opposing or neutralizing the action of the outgoing main-line current upon the home relay. In this class are included all the so-called differential systems, such as Gintl's, Frischen's, Siemens's, Farmer's, Stearns's, Haskins's, and others. Secondly, by placing the receiving instrument in a neutral position in respect to the outgoing currents, corresponding to the position of the galvanometer in a Wheatstone bridge or analogous apparatus, when the resistances are adjusted in proportion. In this class are included the methods of Gintl (chemical), Nystrom, Maron, Stearns, Vianisi, G. Smith, d'Intreville, and others, in which the neutralization is effected in some cases by a local battery, and in some cases by dividing the current of the main battery; but in all cases the outgoing main current passes around the relay, while the incoming current passes through it.

In the apparatus about to be described, the home relay is prevented from responding to the outgoing current by the application of a simple and ingenious mechanical device, and all branch or artificial circuits, rheostats, etc., are entirely dispensed with.

In the accompanying diagram, M is the receiving relay, which operates the sounder S in the usual manner by means by the local battery *l*. The armature lever A of the relay turns on an arbor at *a*, and plays between the front and back contact stops *b* and *c*. D is a contact lever having its fulcrum at *d*. When the transmitter T is in its position of rest, its projecting arm *t* is in such a position that the arm D is drawn against it by the tension of the adjustable spiral spring *s*, as shown in the drawing, and is, therefore, in electrical contact therewith; but when the armature of the transmitter is depressed, the arm *t* is withdrawn, and the lever D falls back, by the tension of its spring *s*, against the projecting stop a_1 of the relay armature A.

The connections are arranged as follows:

One pole of the main battery E is connected to the fulcrum *a* of the relay armature A, and the other pole to earth at G. The fulcrum of the transmitter T is also connected to earth, a spark-coil *r* being inserted, equal in resistance to the battery, in the usual manner. The line L goes first to the helices of the relay M, and thence to the fulcrum *d* of the contact lever D. The transmitter T may be worked directly by hand in the same manner as an ordinary key, but it is preferable to arrange it in the ordinary way with a local magnet *m* and key K, as in the figure.

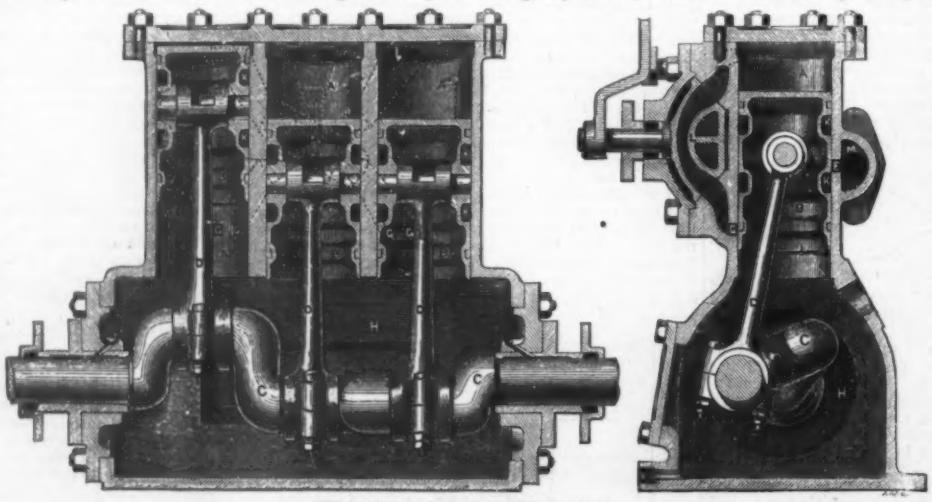
It being understood that the diagram represents the normal position of the apparatus when not in use, the principle of its operation will be very easily understood. The armature spring s_1 is adjusted to correspond to the incoming or received currents from the battery of the distant station. When the home station has its key K open, as represented in the figure, the relay and sounder respond to the writing of the distant operator, the same as the plain relay; the currents entering at L pass through the relay M, and thence find their way to the ground by way of the contact lever D, transmitter T, and spark-coil *r*. The upper spring *s* is so adjusted that when acting in conjunction with the spring s_1 their combined pull will hold the armature lever A in its back stop *c* with sufficient force to withstand the attraction produced in the relay magnet M by the action of the main battery E, either at the home or at the distant station alone, but the combined effect of the two batteries, when both of them are in circuit at the same time, will be sufficient to overcome the combined tension of the springs without difficulty. This being the case, it will be seen that when the armature of the transmitter T at the home station is depressed that the arm *t* is drawn back, when the spring *s* pulls the contact lever D against the stop a_1 of the armature lever A, which connects the main battery E to the line through the home relay M, but at the same time the combined tension of the two springs *s* and s_1 is exerted to prevent its armature from responding. If, however, the distant key is depressed, and the battery of the distant station also placed in circuit, the tension of both springs is overcome, the armature A responds to the increased attraction of the magnet M and closes its local circuit at *b*, thus recording the signal from the distant station.

In working this apparatus, it is of course necessary that the main batteries should be placed with unlike poles towards each other, as in the ordinary closed circuit system.

This apparatus may be worked at an intermediate station as well as at a terminal one, the only change being to replace the ground wire by the remaining line wire, as shown by the dotted line L_1.

The apparatus, when set up in this way, may be provided with an ordinary Morse key, with circuit-closer *k* placed in the line circuit. This having been done, the whole arrangement can be "singled up" or converted into an ordinary closed circuit Morse system at a moment's notice by the following procedure: Each terminal station closes the key K and slackens the adjustment of the spring *s*. Each way-station slackens the spring *s* in the same manner, but leaves the key K open. By means of the key *k*, any station, way or terminal, may correspond with any other, precisely as in ordinary working.

When arranged for duplex working, any station, whether



WILLAN'S THREE-CYLINDER ENGINE.

way or terminal, may call any other station and work duplex with them whenever the line is not in use elsewhere.

This apparatus has been tested in practical service, both for through and intermediate business, upon circuits of various lengths, up to 450 miles of No. 6 gauge wire, and has proved entirely successful. It may also be used at intermediate or way stations in connection with the Stearns differential duplex. The simplicity and convenience of this apparatus are very remarkable, and it is quite probable that it will be found useful upon many lines where an ordinary duplex would hardly meet the requirements of the service.

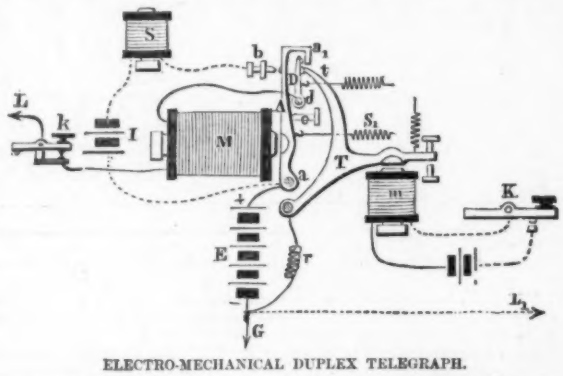
The inventor of this ingenious duplex is Mr. Gerritt Smith, of Astoria, N. Y., now Assistant Electrician of the Western Union Telegraph Company at New-York.

THE production of plate glass, but recently introduced into this country, is making very rapid progress. There are now three polished plate-glass manufactories in the United States—one each at New-Albany, Ind., Louisville, Ky., and St. Louis, Mo., and one rough plate-glass factory at Lenox, Mass.

[The Farmer.]

HOG-KILLING.

HOG-KILLING is performed in Cincinnati on a large scale and with great dexterity and rapidity, if we credit a description of the process as given in the *Cincinnati Commercial*. The ground-floor of the hog-killing establishment contains some five or six hundred animals at a time. From thence they are driven up a gangway to the slaughter-pen, where an "able-bodied, colored gentleman" claps a chain round their legs one at a time, and the pressure of a steam lever jerks the animal into the air. He is now suspended on a horizontal bar about 30 feet long. The chain by which he is suspended slides along the bar, and before he fairly comprehends the situation another man plunges a knife into his throat and taps the life current. He squeals and kicks about half a second, and before the "vital spark has fled," has beside him a former comrade of the pen, who has met with the same misfortune. There is thus a constant line of stuck hogs passing down the bar. The personal pride of the pig-sticker is to have very little, if any, squealing after he has pierced the jugular vein.



ELECTRO-MECHANICAL DUPLEX TELEGRAPH.

When the hogs get to the end of the bar, if dead, they are plumped into an enormous tank of boiling water, eight or ten at a time, and are then quickly lifted out by machinery and thrown out singly upon a long wooden table, on which they are scraped by twelve or fifteen men. They start rough, shaggy, and dirty at one end of the table, and reach the other end as clean and white as may be. At the far end of the table, one man cuts off the head, another flops the bloodless trunk over to a gang below, who "gut" him, hang him up, and cool him off with a stream of water. The entrails and fatty substance taken out and the hams dressed, the cleaned hogs are hung on runways between the joist of the drying-room and run into that department to cool. Nearly all the houses will "hang" about 3500 hogs on a floor. In this room, when the hogs are sufficiently cool, they are cut up into all the various forms of pork—hams, shoulders, middles, etc., and the men who do the cutting use their knives and saws "with the skill and precision of anatomists, cleaning a bone, when it is to be thrown away, so perfectly that a hungry dog would pass it by in disgust." To cut up 1000 hogs is now considered only a fair day's work for one man, and in the busy season even more than that amount is exacted. The fatty portions are boiled and steamed in huge iron vats, and when the lard is "done," it is pumped into a receiver, from which it is drawn into the tierces in which it finds its way to the market. The bristles, says the *Commercial*, go to the brush factory or mattress-maker; the brains become "head-cheese," and the feet are sold at the restaurant as "Irish quail," and the blood, which flows into a big wooden vessel directly under the killer, is warmed by steam pipes until it congeals into a sort of jelly, and is then readily sold as a fertilizer. It is claimed that by cutting off the head the hog is more speedily cooled, and the lard, tongue, and head pieces are ready a day in advance of the old method. The hams are also "faced" and the inside fat taken out while the hog is still warm, instead of waiting for it to cool as formerly, and the innovation is said to be very advantageous. Such a rapid process of pig-killing forcibly reminds us of the fabled American machinery, in which a pig is put in alive at one end and comes out in a few seconds at the other in the form of salted pork and ready-made sausages. Truly the Yankees, like the ants, are a great people!

PHOSPHORUS.

PROF. J. L. SMITH remarked in a recent lecture that one of the largest manufacturers of the article, when he was a young man and a student of chemistry, knew it only by a small roll two inches long, which was kept in the laboratory where he studied, more as a curiosity than any thing else. This same man now draws it out by machinery, in a rope or cord, many miles in length, and sends it off by tons to all parts of the world.

The improvements made in the manner of its production may be inferred from the fact that in its first use in the manufacture of lucifer matches, it was sold at the rate of $20 per pound; while the price now does not exceed one dollar for the same quantity. This economy in its production has been brought about through the aid of science in the improvement of chemical processes, whereby cheap material can be used in its manufacture.

There are now some fifteen phosphorus factories in the world—one half of which number is in Germany. The total quantity produced is something over 250 tons annually—about one half of which is consumed in the manufacture of matches.

One of the most remarkable discoveries in the chemistry of phosphorus was that made about fifteen years ago by Schotter, in producing what is known as amorphous phosphorus. It is only by this wonderful change in its character, by which its inflammability is so reduced as to allow of its being handled with impunity, that its use has become so general and safe in the art of match-making.